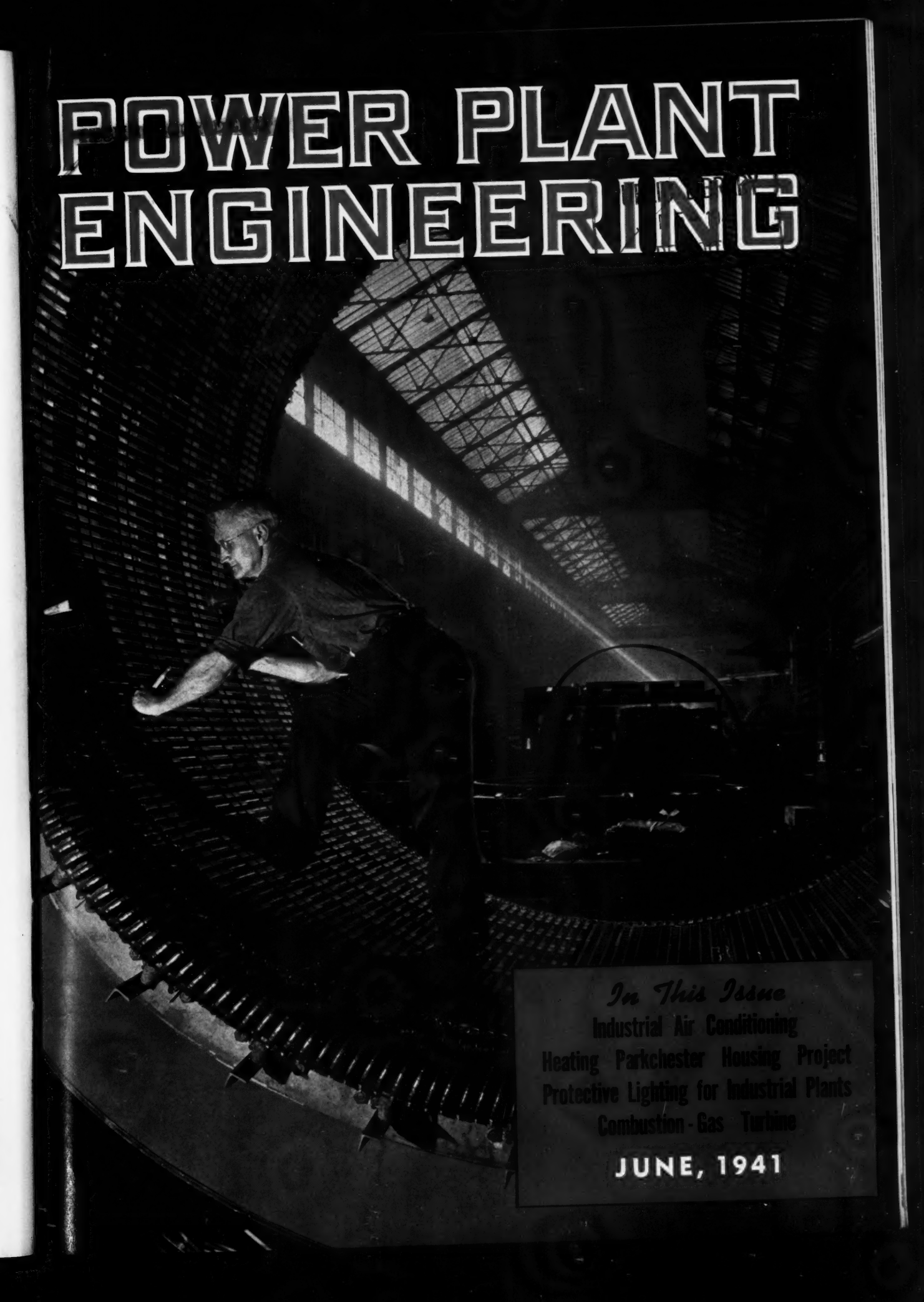
POWER PLANT ENGINEERING



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Combustion - Gas Turbine

JUNE, 1941

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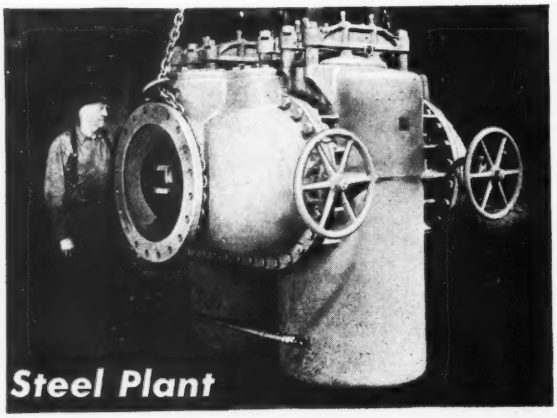
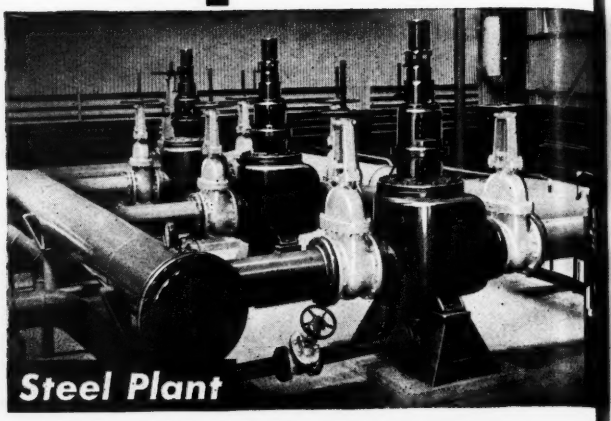

Steel Plant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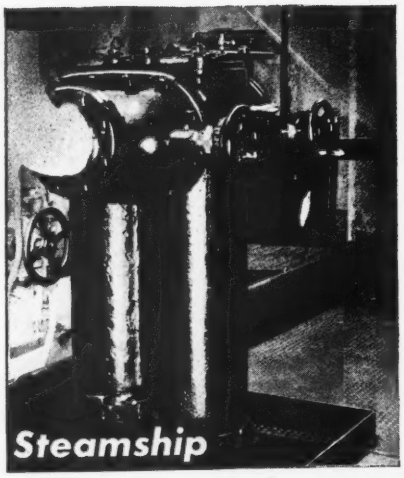
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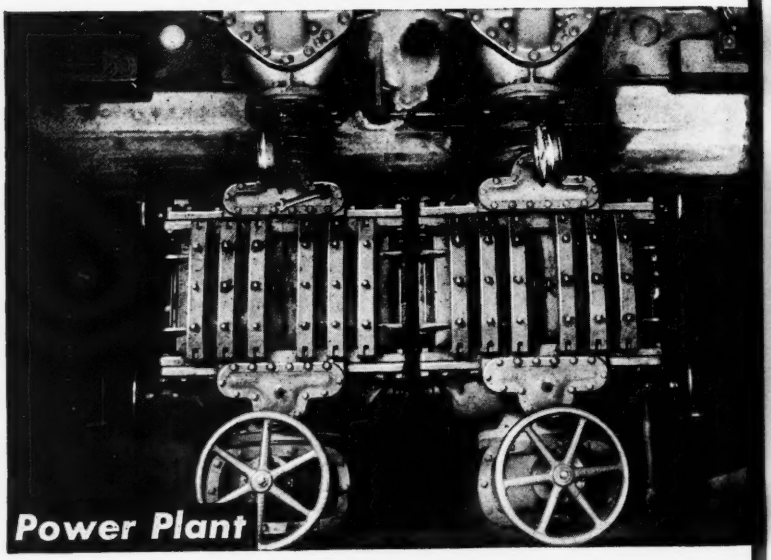
Power Plant

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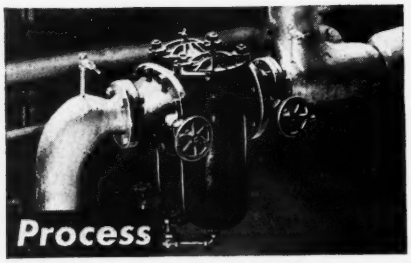
Process

Municipal Plant

ELLIOTT

POWER PLANT ENGINEERING

JUNE, 1941
VOLUME 45, No. 6

Cover: 40,000 Electrical Horses. Skilled hand work was required in building this giant motor to be used in creating wind speeds of 400 miles per hr. in the new wind tunnel at Wright Field, Dayton, O. A view in the Westinghouse East Pittsburgh works where this 40,000 hp. motor was built.

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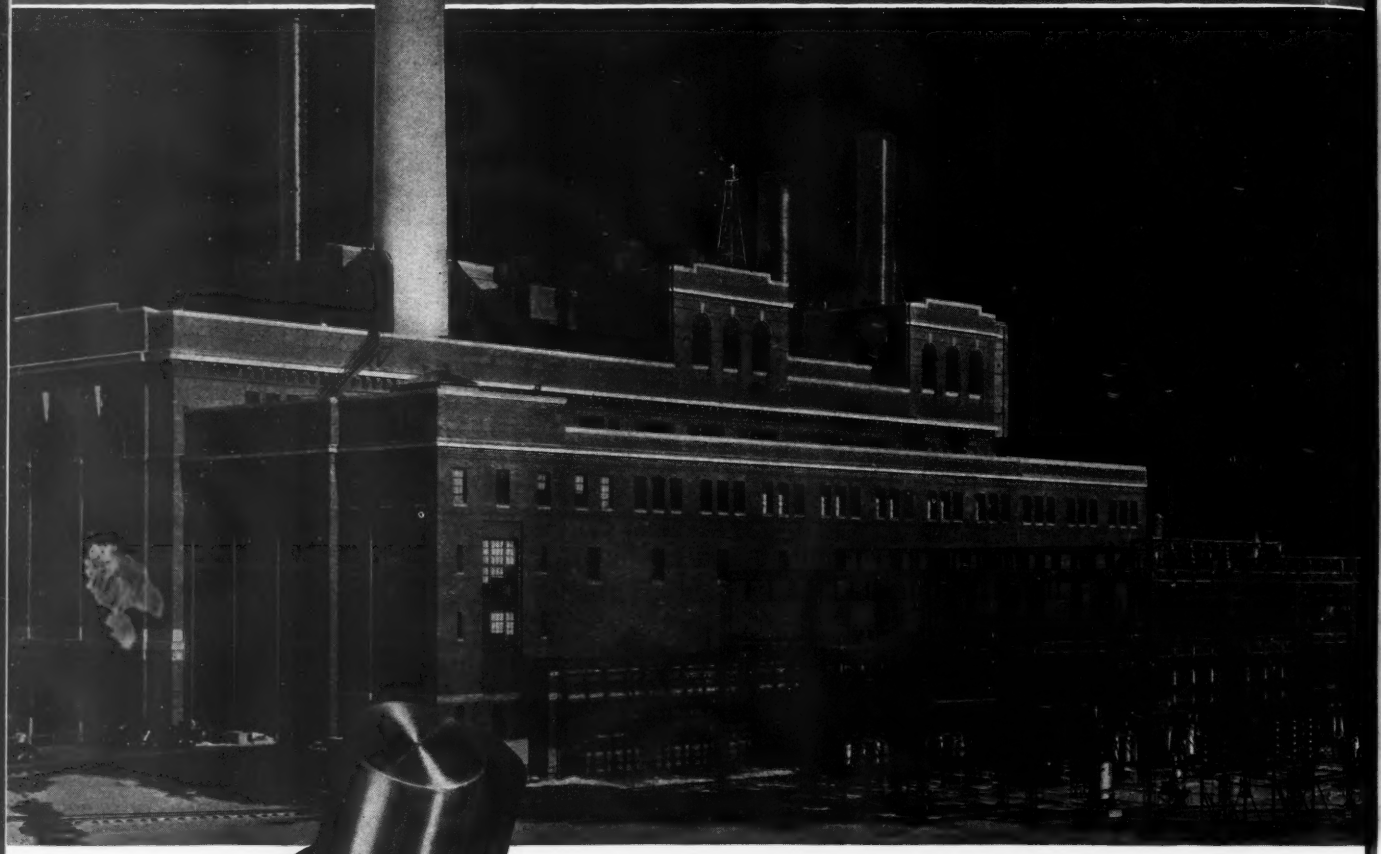
YARWAY IMPULSE TRAPS
At Hartford Electric



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THE VOICE OF INDUSTRY

A. H. PHELPS on

SUBSTITUTES AND POST WAR SURPLUSES

THESE are times when everyone who is really interested in the welfare of his country is spending energy in productive thought in assisting the government in what it is endeavoring to do, but the best efforts and genius in the engineering profession must be used if we are to develop maximum use of our natural resources in this great emergency—use limited resources where the need is vital and find acceptable substitutes for them where the need is less urgent.

Men with vision should and will face the difficulties which lie ahead and will (afterward) develop new uses for material surpluses (uses) which will mean industrial development and expansion in the United States—work for more people and, perhaps, solve many of the economic problems which a war always brings. Instead of these surpluses therefore becoming a drug on the market, they may prove a blessing in disguise in working out our economic problems after the war.

Fundamentally, there can be nothing wrong in changes which enhance our supplies. Businessmen must learn not to fear the superabundance of materials which American engineering genius is making available to them. They should instead be regarded as potential instruments for good, presenting a challenge to the imagination, skill and energy of American business—a challenge which will be met and out of which will arise a higher standard of living and a better America.

Nevertheless, I am not blinding my eyes to the adjustment period which is bound to follow the war nor to the immediate problem. As the chief purchasing officer of my company it is my responsibility not only to supervise the routine work of supply which is so highly important today but also to build a real plan for future supply, having in mind the national interest and that of my company.

When it first became apparent that the nation was launching into a major defense program, the Company made a survey of its existing facilities to determine how it could best serve the country in the emergency. Our executives went to Washington and offered our services to the government for the manufacture of electrical and other types of equipment needed in the defense effort. The immediate transition from peace to emergency conditions had long been planned for.

During the World War and ever since, businessmen regarded a connection with the War Industry Board with honor and respect. The office of Production Management is staffed with men taken from industry, and has been organized to operate with American business to facilitate carrying out the National Defense program. This is a great testimonial to the effectiveness of our free American system of developing and using the real business brains in a great emergency.

Westinghouse has bent its best efforts toward support of the armament program; we have not, however, relaxed in our work to keep our non-defense plants operating, for we believe it highly important to the future of our Company, as well as to the future of the nation, that the non-defense portion of our industrial structure be maintained on a healthy basis whether by material substitutions, product changes, or maintenance of minimum supplies of strategic materials.

Of course, we would rather produce products that bring human happiness than materials for human destruction, but we are dedicated first to do our full part in the National Defense. In line with the belief that non-defense activities should not be dropped, we have made every effort to conserve strategic materials and still keep our product lines going by making various substitutions, to conserve aluminum, zinc, nickel and other critical items. We have almost entirely eliminated the use of magnesium in our operations.

In addition, new industries are rapidly developing—the plastics, for instance. Many of you know that certain articles are being made and will be made in increasing volume from plastics and will never again be made from metals. One with a short vision would see that this industry and the plywood industry constitute a real threat to the future of metals. But most of you have lived long enough to have better judgment. Substitutes that have been brought in in the past have created other uses for the metals that were displaced, and, thus, surplus metals have been absorbed in other ways. I have great confidence in substitutes, and metals will be used in greater quantities than ever before after the slack is taken up.

ANDREW H. PHELPS, General Manager of Purchases and Traffic of the Westinghouse Electric & Manufacturing Co., is a Cornhusker who has ranged far from his native Nebraska. As former sales manager and director of public relations of McGraw-Hill and later as field manager of the U. S. Chamber of Commerce, he knows American Industry from coast to coast, and in his present position has had need of all his diverse knowledge in doing his best to meet the urgent demand for materials and substitutes to carry on during the present emergency.

The widespread use of substitutes has caused some concern among businessmen, but Mr. Phelps, speaking to the members of the Mining Club in New York on April 8, said the post-war super-abundance of materials was not to be feared, rather it offers every indication of being a real aid to solving future economic problems.

Mr. Phelps finds no shadow of doubt on the "character and ability of the American people to . . . rebuild the American economic system on a strong and enduring basis when this war is over." To state the problem in a complicated, but seemingly appropriate figure of speech (for which by the way Mr. Phelps must be absolved of all blame), the problem of the engineer is: to forge the plowshare into a sword; find a substitute to make a better plowshare; and when the emergency is over reforge the sword into a better tractor to pull the better plow so as to keep both at work.

THOR'S WORKSHOP

THOR, the maker of thunderbolts, hammered out his products on an anvil with great display of muscular activity and much fireworks. What his workshop looked like is not generally known, no photographs were ever taken but it probably bore no resemblance to the picture shown above. This eerie collection of polished columns and glittering steel, however, is a modern version of Thor's workshop; it is part of the one million volt lightning generator installed in the Chicago Museum of Science and Industry. ¶ Built by Westinghouse, it creates artificial lightning strokes as part of an exhibit to show the general public what happens when lightning strikes the distribution lines that bring light and power to their homes. Curiously enough, for all its striking power, the entire unit operates from a standard 110 v. source. It incorporates an adjustable synchronizing trip mechanism that enables the operator to discharge the lightning stroke at any point during the alternating current cycle.

WITH THE EDITORS

◆ **BOTTLENECKS** . . . "It will take years to man the growing field with competent, experienced engineers who can be trusted with the care and operation of those finely machined turbines and other expensive equipment after they are installed." That statement in an editorial item published in the October 1940 issue of Power Plant Engineering under the heading "Bottlenecks" is, we believe, well founded by facts and would not be questioned by any engineer who has attained a degree of proficiency enabling him to take charge of even a small portion of a power plant. Yet it is being challenged by managers who must depend upon trained men to operate their power plants.

From a letter recently addressed to the Editor, we quote: "The writer is a young engineer employed as a water tender in the plant of a public utility corporation. He served his apprenticeship as a Cadet Engineer, Deck Engineer, and Junior Engineer at sea. He is licensed in the City of New York and also in the State of New Jersey. He has bought books by Croft and others and has studied diligently. He is fully capable of standing boiler room or engine room watch. He is a high school graduate and a very good mathematician. Now what I am leading up to is this:—When he went to the production manager and requested deferment from the draft on the grounds of occupation, he was politely told that his services were not valuable enough, and they could pick up a man off the street to perform his duties with six weeks' practice. On the other hand, some welders in the ship yards are being deferred on the grounds of being indispensable.

"If you will read the above and then re-read your editorial you will probably come to the conclusion you were wrong and should write another editorial reversing yourself, stating that engineering is not worth much."

◆ **BEGINNERS** . . . It is granted that certain work about a power plant can be performed, under the direct, constant supervision of an experienced man, by a beginner, even a beginner without a common grade school education. It is also true, in many cases in recent years, that technical school graduates have sought the most menial jobs at subsistent wages in order to be employed and gain experience, awaiting the time when advanced responsibilities will be placed upon them as a result of competence. These men who are performing services necessary for the operation of a power plant may be replaceable, but the service cannot be eliminated or they would never have been hired and if the power plant is a public utility or serving an essential industry, the management has good reason to consider every competent, faithful employe an essential workman.

◆ **DEFERMENT** . . . In his address before the Midwest Power Conference, reported in the May issue, Dr. Harvey N. Davis, President of Stevens Institute, quoted a high-ranking Army man as saying, "The trouble is that a lot of these industrial fellows think it is noble and patriotic not to ask for the deferment of any man who hasn't been with them at least six months. Take such and such a company in your area. We've been working on them for three months now, and at last we've pounded some sense into them. They're beginning to ask for all the deferments they ought to have been asking for all along." Then Dr. Davis added, "I understand that some of the public utilities are among our worst offenders in this pseudo-patriotism."

Men may be replaceable in power plants at the cost of time and safety. If the power plant is an essential factor in the defense program, the management can ill afford to spend the time necessary to train a new employe if it can be avoided, nor should he run the risk of accident, failure of equipment or possible sabotage committed by a new man whose trustworthiness has not been tested out.

Is the power plant essential to the Government's Defense Program? Many of them are considered so by the highest government officials who are striving to have the production of power equipment speeded up. Why? To have it generate power, of course. And would it be wise to have this equipment operated, even under supervision, by the inexperienced man off the street? The negative answer seems obvious, for the exactitude with which power equipment must operate requires a familiarity with the details of the equipment itself as well as a knowledge of many fundamental principles. The water tender's duties may not, in fact, should not, be physically arduous, but he must be mentally alert every instant he is on duty, and act quickly and correctly when the water in the boiler fails to function according to plant requirements.

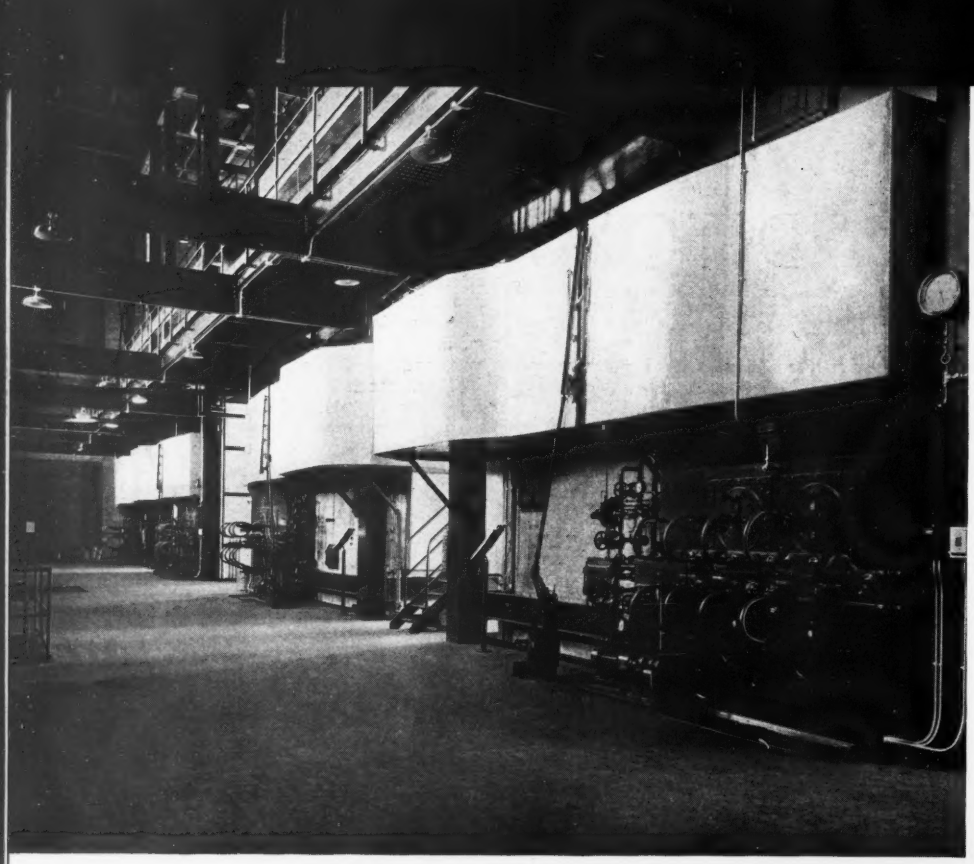
Due to the fact that government authorities at present consider material needs greater than the need for men to be trained for military service, we believe managers will be doing a patriotic service to the country by recommending deferment, not exemption, from military training for capable and trustworthy employes in power plants that in any way contribute to the National Defense Program.

◆ **SHIFTING LOADS** . . . Government authorities are pointing to the Defense Program as significantly changing the pattern of demand facing industrial communities over the next few years. Those prominently in the ascendency are, among others, shipbuilding, airplane manufacture, ordnance and ammunition, machine tools, chemicals, nonferrous metals and steel. These industries use more electricity per laborer than the average, and as they grow, will be demanding utility generated power in increasing quantities.

Industrial loads on utility plants during recent months has shown a proportionately higher percentage than power used by other groups. While unquestionably greater industrial production may be given credit for the increase, technological changes in production methods and equipment are responsible for a considerable portion of this increase. Manufacturers have found many new uses for electricity in process work as well as increased use of power driven machinery.

In the domestic field, many of the electrical household appliances were scarcely existent fifteen or twenty years ago but today they account for a considerable portion of the domestic load. Among these appliances are refrigerators, radios and phonographs, cooking ranges and water heaters. With increased demands for manufactured products, industries are being forced to find quicker and less expensive methods of turning out their products so we may expect greatly extended uses of electric furnaces, electric welding, electro-metallurgical and electro-chemical processes, X-ray examination of metals, air conditioning and dust removing equipment.

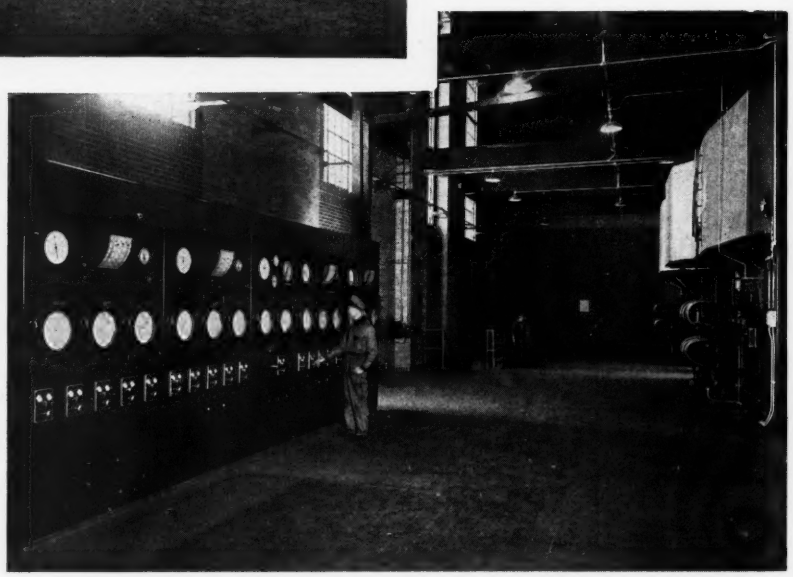
◆ **FIXED PRICES** . . . Everybody is not happy about the rulings of the Director of the Bituminous Coal Division who is responsible for establishing minimum prices to be charged at the mines. One association wants the redistributors' discounts changed; another group charges violation of law by certain individuals; a corporation wants revision of prices in one group; others want establishment of prices for certain mines; price changes on certain sizes are wanted; freight rate differences enter into the petition of another group; price reduction is wanted by one mining company; another petitions for a reclassification of its coals from low volatile to high volatile; a manufacturer wants renewal of exemption; several companies want to establish agencies; another district wants relief from competition between code members and various vendors with existing stocks; price modification wanted for coal for railway use; one district wants revision because of railroad and truck competition. These are typical of the hundreds of complaints that are being submitted for hearings, and we have not mentioned the consumers' side of the question—they only pay the bills.



STEAM

Fig. 1 (Left). The boiler fronts and firing alley. Each boiler is provided with four Peabody wide range oil burners capable of burning 2200 lb. of oil per hr. each

Fig. 2. A view showing the Bailey Boiler Control Board. This board consists of four boiler panels and one master control panel



WITH WAR and the threat of war in the daily headlines, there is steadily progressing toward completion in the Bronx, New York City, the most comprehensive single plan for housing ever evolved in the United States. Parkchester, the new "city" which is scheduled for completion by the Metropolitan Life Insurance Company late this year, is already over half occupied and week by week enlarges its long list of tenant families.

Parkchester's boundaries measure over two miles. Its area is 129 acres. When it is completed, its 51 fireproof elevator apartment houses, 6 to 12 stories high, will contain 12,200 apartments for occupancy by families of middle income. Suites range in size from two to five rooms. Greatest in number are the threes. They rent for from $39 to $53 monthly, gas and electricity included.

With a population of about 18,000 already living within its bounds, Parkchester has taken its place as one of New York City's most attractive residential areas. When it is fully occupied, its population will be about 40,000, the population of an average American city. Only 27 per cent of its land is covered by buildings. Over 51 per cent is set aside for lawns, gardens and play areas. Almost 4,000 trees as well as many thousands of shrubs and ground-cover plants have been placed in the ground.

Store organizations of the highest type function in its shopping areas and "down-town" business section. Parkchester has over 5,000 lineal feet of shop street frontage. Its 2,000 seat theater has been open since Winter. There are two bank branches and a post office. Two of the five ramp garages, each with a capacity of 500-600 cars, have been doing business for some time. Macy's will open its first New York branch store there in a few months.

While there are innumerable aspects of interest in this great development, the one that will be considered in this article is that of supplying heat to the buildings. Since the item of fuel cost is the largest single item in the maintenance of New York dwellings, both the initial investment in heating equipment and the operating cost were given the most careful consideration. A great amount of attention was given to the insulation of the wall surfaces and a special construction using glass wool with a vapor stop between the brick and plaster was finally decided upon.

Steam was selected as the heating medium. This is supplied from a single central heating plant at a pressure of 100 lb. per sq. in. to a number of reducing valve stations where it is reduced to the pressure maintained in the radiators or convectors as they are called. The pressure maintained in the radiators varies somewhat, depending upon the outside temperature. Dur-

FOR PARKCHESTER

ing most of the heating season this pressure will be slightly below atmospheric pressure but in extremely cold weather the pressure goes slightly above atmospheric.

The most interesting single feature of the heating system is in the way the radiators are connected without the use of valves of any kind. This is shown in Fig. 5. A single vertical riser is carried from the basement to the top floor ceiling where it connects into the topmost radiator. All radiators in a vertical group are connected in series, each radiator constituting an offset in the downcomer which alternates in its position from one side of the window to the other on successive floors until the line reaches the basement where it is trapped into the return main. The dog-leg offset provides a cushion for taking up expansion strains, the radiator and piping weight being supported by a bracket integral with the enclosure at the outlet end, thus distributing the weight of the installation floor by floor.

The radiators and piping are connected solidly without valves. It is evident, therefore, that insofar as the system has been described, there is no means for controlling the temperatures on the individual floors. This, however, is brought about by the use of radiator enclosures fitted with dampers to regulate or stop the flow of air through the enclosure. The enclosures are four inches wide, extend just far enough beyond the line of the window jamb to house the entering and leaving riser. The pressure in the radiators and therefore the temperature of the steam in the radiators is controlled in accordance with the outside temperature, but the occupants of the apartments can control the temperature in the rooms by manual control of the enclosure dampers.

Altogether there are 29 pressure reducing stations or heater rooms as they are called. Each of these stations serves approximately 450 apartments. In addition to being pressure reducing stations, these heater rooms also contain the hot water heaters, the condensate return equipment and in many instances the basement sump pumps.

Each pressure reducing station consists of two pressure reducing valves in series. The first valve is adjusted to maintain a slightly higher pressure than the second valve; it, therefore, remains wide open as long as the second valve is working properly.

The high pressure distribution system, which as already mentioned, operates at boiler pressure, is designed for parallel flow of steam line condensate except at points where it becomes necessary to increase the elevation of the pipe. Such increases in elevation are accomplished by means of vertical risers. Ahead of each riser a large condensate drip pocket is welded into the line and where possible the condensate is led to the

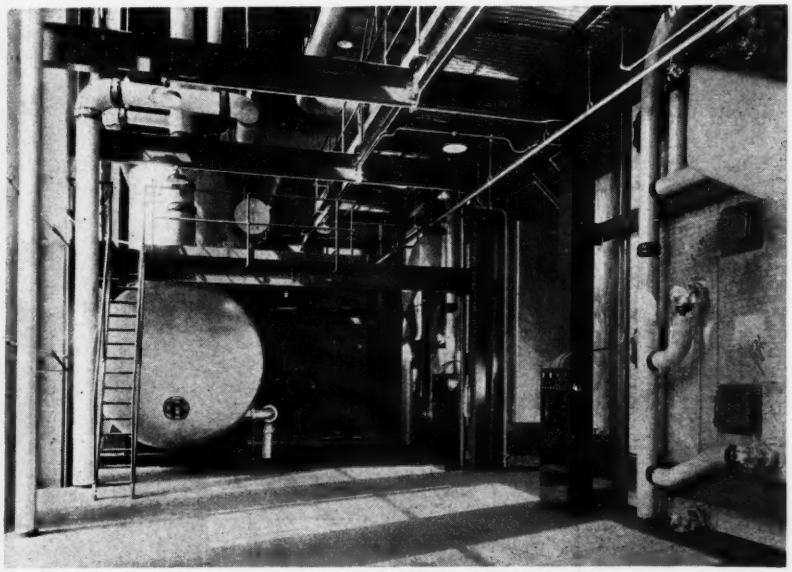


Fig. 3. A view of the rear of the boilers showing the Elliott deaerating heater and the Vulcan soot blower control panels

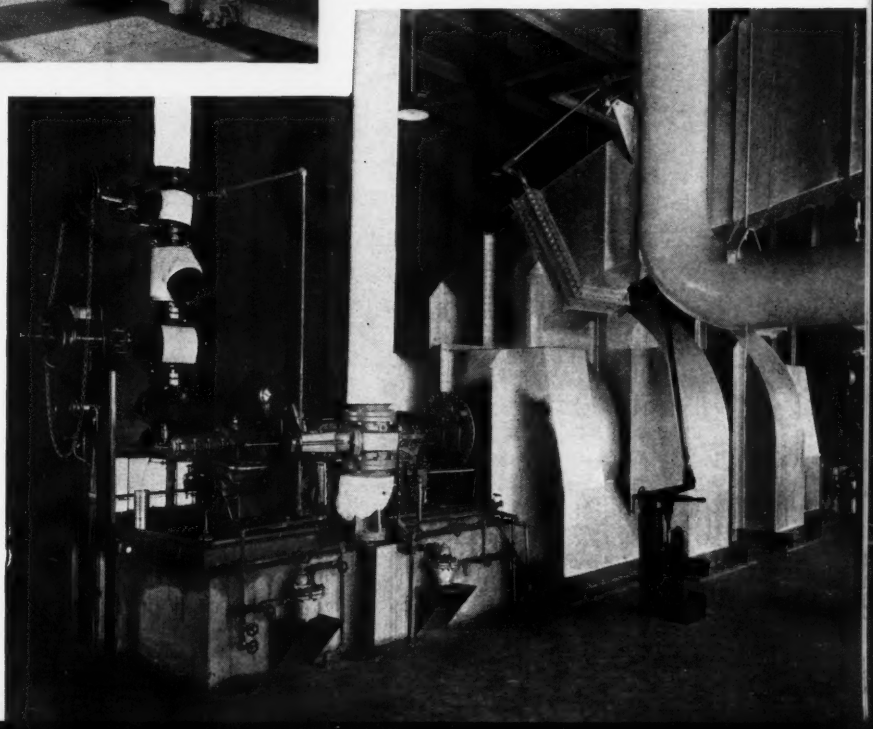


Fig. 4. One of the Sturtevant turbine driven, duplex forced and induced draft fan units

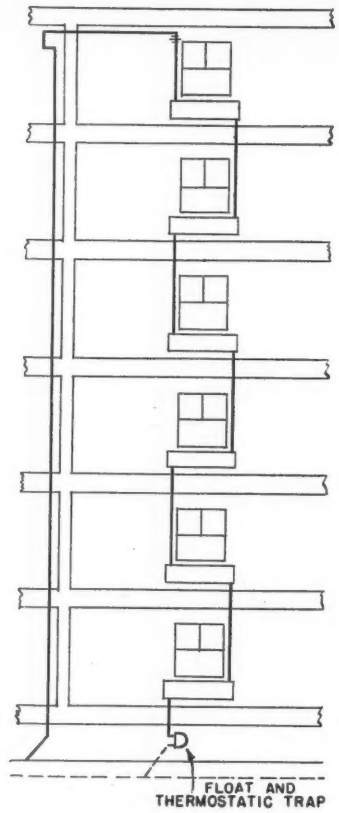


Fig. 5. A diagram of the single pipe heating system

nearest condensate pump to be returned to the plant.

The piping is installed in poured concrete ducts close to the surface under shrubbery, macadam walks, etc. The lines are insulated with double standard 85 per cent magnesia, and are covered with waterproofing and a copper jacket. The entire line from the boiler plant to the pressure reducing valves in the various heater rooms is of welded construction. It is supported on roller pipe supports, spaced according to the pipe diameter and guided with equally spaced guides. Steam line expansion is taken care of by packless welded expansion joints, both single and double. These joints are located at angle points in the transmission line or wherever branch lines are taken off for a building or group of buildings. In long runs the steam line is anchored halfway between expansion joints to reduce the traverse to a reasonable amount.

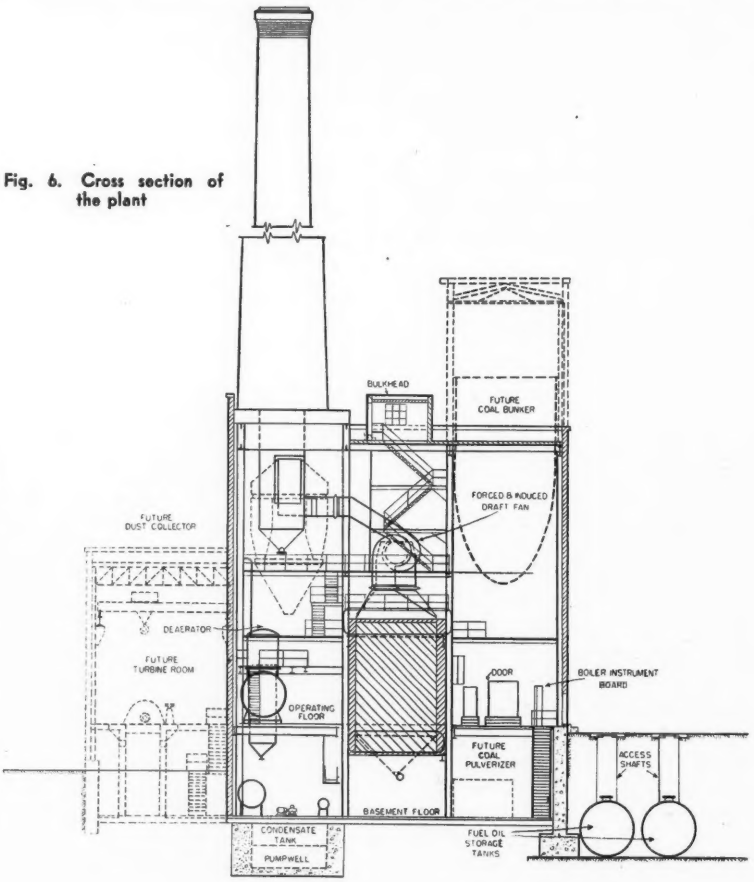
The Boiler Plant

With this brief description of the heating system in mind we will now turn to a consideration of the boiler plant which supplies the steam to the system. The boiler plant is unusual, in a number of aspects. First, in its size; for a steam heating plant serving a single project, it is unusually large both in steaming capacity as well as in actual dimensions. The latter is due partly to the fact that although oil is being used as fuel now, provision was made for the possible future installation of coal bunkers and pulverized coal burning equipment and also for the future installation of economizers. This gives the plant an unusually spacious atmosphere, but even when these future provisions are taken into account, the plant is still of ample proportions. Another striking feature of the plant is the interior decorative scheme—the generous use of color and the fine attention to detail. The floors are of red tile; the piping and equipment are painted in various colors to conform to a definite color code.

The general arrangement of equipment is shown in Figs. 6 and 7. Four 135,000 lb. per hr., two drum "D" type Foster-Wheeler boilers are set in symmetrical pairs in a single row. These units have completely water cooled furnaces, oil fired at present, and designed for a working pressure of 450 lb. per sq. in. At the present time operation of these units is at 100 lb., but in selecting them it was necessary to consider the possible future installation of turbogenerators and so this higher pressure was decided upon. Future design, as already mentioned, also includes the installation of pulverized coal burning equipment, and the furnaces of these boilers are designed with that in view. The design of these boilers represents an effort to obtain a high degree of furnace cooling with low head room. The overall dimensions are only 25 by 21 by 29½ ft. In order to meet the low head room requirements and the low initial operating pressure the top drums of these boilers were made 72 in. in diameter and the number of circulating tubes increased.

Gas produced by the four oil burners in each furnace passes toward the rear of the furnace, reverses its flow through 180 deg. and returns toward the front of the furnace to the entrance into the main boiler tube bank. Turning again through 180 deg., the gases

Fig. 6. Cross section of the plant



leave the furnace, passing around the first baffle through a slag screen consisting of two rows of 3¼ in. diameter tubes, and continue horizontally toward the rear of the unit across the tubes in the first boiler bank. Continuing their flow in horizontal planes they turn again at the rear of the first boiler bank through 180 deg. around a second baffle into an open space between tube banks where the direction of flow changes from horizontal to vertical. After turning up vertically the gases pass over the top of a third baffle and downward through the second tube bank. Emerging from this bank at the bottom they turn upward and pass through the vertical tubes of the air preheater on their way to the stack. No economizer is provided in the initial design but space has been left for their future installation as well as for a 600 deg. superheater.

The forced and induced draft fans are located directly above the boilers. Each boiler is provided with its own fans, both forced and induced draft fans being mounted on the same shaft and driven through reducing gears by 328 hp. turbines. Each turbine is provided with two automatic steam inlet valves to obtain efficient operation at low speeds.

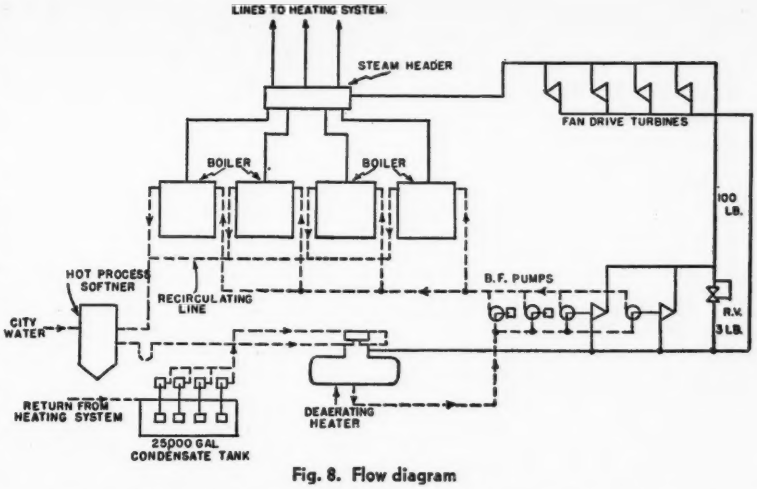


Fig. 8. Flow diagram

The induced draft fans discharge through a well designed system of breechings into the base of the stack. Provision is made for the future installation of dust collectors in connection with the use of pulverized coal as fuel. The stack, which is supported by the building steel, is of radial brick and extends 204 ft. above the roof of the boiler plant.

Oil Burning System

The oil burning system installed is well adapted to handle the wide range in load that can be expected at this plant. Four Peabody wide range mechanical atomizing oil burners are installed in each furnace, these operating in connection with the Peabody differential pump system. This system provides an extremely wide range in capacity without the necessity of changing burner tips or the cutting in or out of burners and without any manual adjustment of the burners. In this system a differential pump maintains a high oil pressure in a ring circuit supplying the burners on each boiler irrespective of the oil pressure in the main supply system.

Fuel oil may be delivered to the plant by truck from tidewater, or by tank cars. Four underground storage tanks, each about 75 ft. long and having a capacity of 60,000 gal. each, provide a 15 day supply for the coldest winter weather. Each tank is provided with a heater using exhaust steam.

From these tanks, the oil passes through a valve manifold and pumped to the three oil heaters by one or more of four motor driven high pressure screw pumps. The oil is delivered to the burners at a temperature of about 220 deg. F.

The plant operates under a complete automatic Bailey combustion control system. This is an air actuated system controlling oil to the burners, the fan turbine speed and the fan damper positions. The arrangement includes Bailey air operated shut-off valves in the fuel oil lines to act in case of an excessive pressure rise in the furnaces. The control is centered on a control board which also carries the necessary boiler room instruments. The system is so arranged that it can be switched from complete automatic to manual control for starting a

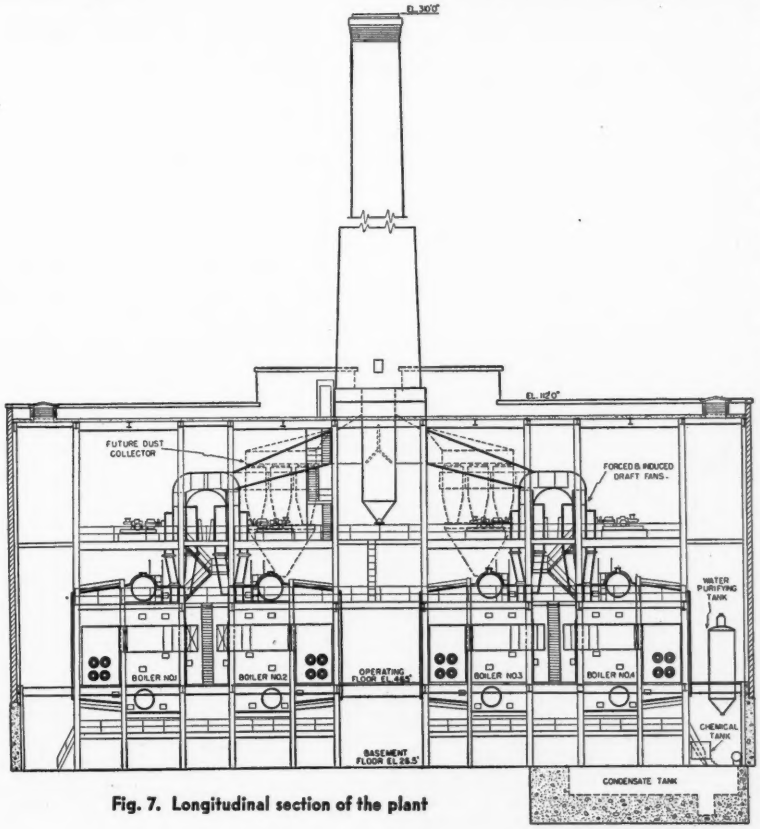


Fig. 7. Longitudinal section of the plant

PRINCIPAL EQUIPMENT IN PARKCHESTER HEATING PLANT

General

LOCATION—Bronx, N. Y.

OWNER—Metropolitan Life Insurance Co.

SERVICE—Steam Heating Plant

CONSULTING ENGINEERS—Burns & Roe, Inc., New York, N. Y.

Boiler Equipment

BOILERS—4, "D"-type. 2 drum, bent tube boilers complete with water-cooled furnace and tubular type air preheater with space for future superheater, designed for operation at 450 lb. per sq. in., 600 deg. F. at 50,000 lb. per hr., 610 deg. F. at 75,000 lb. per hr., 615 deg. F. at 135,000 lb. per hr., at superheater outlet. Heating surface in boiler 11,000 sq. ft. Rated capacity, 135,000 lb. per hr. Boilers are oil fired but designed for future use of pulverized coal. Foster Wheeler Corp.

FORCED AND INDUCED DRAFT FANS—4 Duplex units consisting of one F.D. and one I.D. fan on the same shaft and driven through 412—1030 r.p.m. reducing gears by a 328 hp., 90 lb. pressure, 7 lb. B.P. steam turbine. B. F. Sturtevant Co.

COMBUSTION CONTROL—Air actuated system controlling oil to burners, fan turbine speed and fan damper position. Bailey Meter Co.

BOILER CONTROL BOARD—Four boiler panels and one master control panel. Panels contain steam flow-air flow meters, water level recorders, temperature recorders, pressure recorders for fuel oil and feedwater lines and combustion controls. Bailey Meter Co.

SAFETY VALVES—6 safety valves on each boiler, seven 4 in. valves at present. Consolidated Ashcroft Hancock Co.

SOOT BLOWERS—5, air motor actuated steam soot blowers on each boiler operating under complete automatic control. Starting at the furnace, these elements blow in sequence and are equipped with an alarm to mark the termination of the blowing cycle. Vulcan Soot Blower Corp.

BLOW-OFF VALVES—Type C Yarway Seatless. Yarnall-Waring Co.

NON-RETURN VALVES—12 in. non-return valve on each boiler. Edward Valve & Mfg. Co.

WATER COLUMNS—Diamond Bi-Color—Diamond Power Specialty Corp.

FEEDWATER REGULATORS—1 Copes Flowmatic regulator for each boiler. Northern Equipment Co.

BOILER FEED PUMP—4, centrifugal pumps, 2 turbines driven and 2 motor driven, each with a capacity of 345 g.p.m. at 400 ft. head when operating at 3545 r.p.m. De Laval Steam Turbine Co.

BOILER FEED PUMP DRIVES—2 steam turbines, 50 hp., 90 lb. pressure, 4 lb. back pressure. De Laval Steam Turbine Co. Two 50 hp., 208 v., 3 phase induction motors. General Electric Co.

HOTWELL PUMPS—4, vertical, centrifugal pumps each driven by a 15 hp. General Electric Co. motor. Peerless Pump Division, Food Machinery Corp.

FEEDWATER HEATER—Deaerating type. Rated capacity 300,000 lb. per hr. at 19.7 lb. abs. Elliott Co.

Oil Burning System

OIL BURNING SYSTEM—Peabody constant differential system. Each boiler is fired by 4, Type A-18 wide range oil burners receiving combustion air at a temperature of 360 deg. F. and capable of firing 2200 lb. of oil per hr. each. Peabody Engineering Corp.

OIL STORAGE TANKS — 4 cylindrical underground tanks each with a capacity of 60,000 gal. The total of 240,000 gal. is sufficient for a 15 day supply under normal winter conditions. Eastern Steel Tank Corp.

OIL BOOSTER PUMP—Four 25 g.p.m., 317 lb. per sq. in. head, high pressure screw pumps each driven by a 10 hp. General Electric Co. motor. Quimby Pump Co., Inc.

FUEL OIL SUCTION AND DISCHARGE PIPING—Cuno Engineering Co.

FUEL OIL HEATER—Three, Paracoil, steam heaters. Davis Engineering Co.

Miscellaneous Equipment

STEAM QUALITY CONTROL—Leeds & Northrup system which takes a continuous sample of steam leaving the boiler, condenses it and measures the electrical conductivity of condensate. Leeds & Northrup Co.

ELECTRICALLY OPERATED VALVES—Chapman Valve Mfg. Co.

ATMOSPHERIC RELIEF VALVES for Elliott Heater—Atwood & Morrill Co.

EXPANSION JOINTS IN STEAM DISTRIBUTION LINES—Packless, welded, stainless steel joints. Foster Wheeler Corp.

REDUCING VALVES IN HEAT CONTROL ROOM—Leslie Co.

COMBUSTION CONTROL AIR COMPRESSOR 6½ by 5 in.—American Air Compressor Corp.

CONDENSATE RETURN PUMPS — Type CH—A. C. Dunham Co.

BREECHINGS—Turl Engineering Co.

RADIAL BRICK STACK—Alphons Custodis.

TEMPERATURE REGULATORS — (Fuel Oil) Fulton Sylphon.

TANK-O-METERS FOR OIL TANK LEVELS—Uehling Instrument Co.

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boiler unit with each control adjustable either locally or from the board. With the control panel located centrally in front of the boilers, and with all motor operated valves and motor driven auxiliaries controlled from this point, the plant may be operated with the minimum of attendance required by law.

Feedwater System

The feedwater system is shown diagrammatically in Fig. 8. It is simple in principle but quite interesting from the standpoint of actual design. Because of the enormous investment in steam and water carrying lines it is essential that the water and the steam in the entire system be maintained at a high degree of purity and under close chemical control to avoid destruction of piping from corrosion. The system of chemical control used was directed by Shepard T. Powell, consulting chemical engineer. It involves close and regular analysis of the water in the system and that used for make-up, treatment of the raw water in a hot process softener, the use of a Monel-lined condensate tank, the use of sodium sulphite for removal of oxygen after deaeration, the injection of caustic soda for pH control and accurate steam quality control.

City water make-up enters the system through the hot process softener and passes directly to the deaerating heater where it mixes with the condensate. Condensate from the heating system collects in a 25,000 gal. tank installed under

Fig. 9. Airplane view of the Parkchester development as it appeared January 1, 1941

a part of the basement floor of the boiler plant. This tank which is 42 ft. long, 20 ft. wide and 5½ ft. deep is of concrete but is completely lined with ⅛ in. Monel metal to prevent in-seepage of ground water as well as contamination from silica in bare concrete. The joints in this tank are all welded and the whole anchored to the concrete by four inch bolts. To collect any rust or scale which may get back from the piping a sump pit is sunk in the bottom of the tank 6 by 3 ft. and 10 ft. deep. This is also lined with Monel metal.

In the deaerating heater, the water is heated by exhaust steam from the steam driven auxiliaries. The pressure in the exhaust line is usually 5 lb., but a pressure control on the heater is so set that when the steam pressure in the exhaust line drops to 3 lb. it cuts in a supply of live steam, fed through a reducing valve. An atmospheric relief valve set to open at 14 lb. protects the heater in case the relation between the exhaust steam supply and the load is upset.

The deaerating heater is built so as to hold a 20 min. storage of water. The pumps on the condensate return tank are the only elements between the water supply and the boilers and since these are motor driven, it makes the continuous operation of the system entirely dependent on the electric power system. Even though power is supplied by two separate lines, it is conceivable that these pumps could fail and in that event there would be little chance of getting water into the boilers. Thus, by making the heater large enough, at least a 20 min. supply is assured. Ultimately, the amount of make-up needed, it is expected, will be only around 3 per cent.

Steam Control System

As indicated above special effort is made to control the steam quality. Carryover is held to about 1 p.p.m. total solid by moisture eliminators in the boiler drums and special conductivity recording equipment provides for a continuous record of the steam quality for each boiler. Stainless steel sample lines from each boiler connect into a Leeds & Northrup recorder mounted in a specially designed steel cabinet. This cabinet contains the Pyrex flow cell in which the conductivity is measured as well as the necessary cooling coil and automatic temperature control equipment to hold the water sample constant at 77 deg. F. The means for reducing the pressure from the 100 lb. per sq. in. carried in the boiler to the 10 lb. required by the recording unit is interesting. There are no throttling valves of any kind in the sampling lines; the necessary drop is obtained by carefully coiling and adjusting the length of the small stainless steel sampling tubes connected between the boiler and the recording unit.

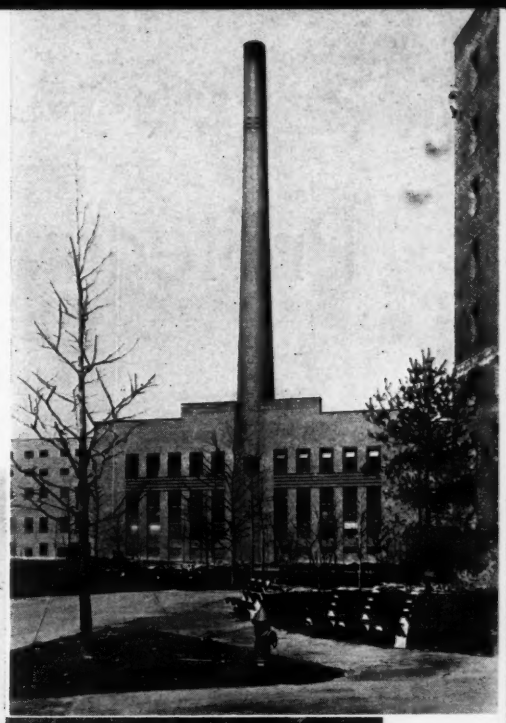
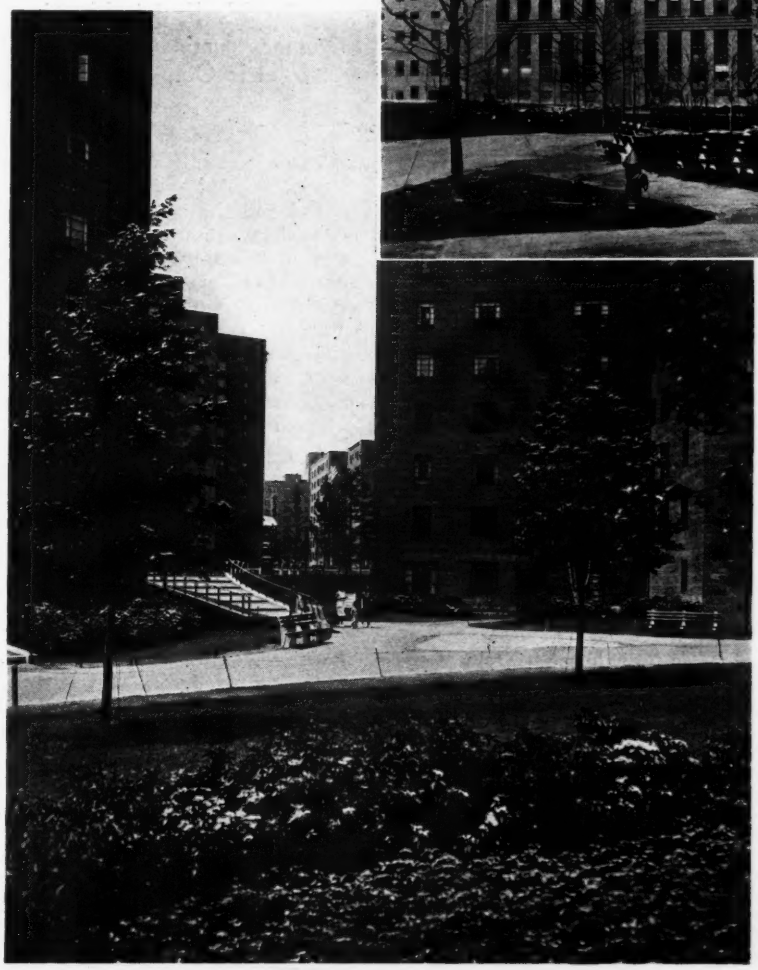


Fig. 10 (Below). Over 51 per cent of the area is set aside for lawns, gardens and play areas

Fig. 11 (Right). A view of the boiler plant



The steam output from all four boilers is fed into a header in the basement from which three main distribution lines lead to the various reducing valve stations throughout the property. Two of these lines are 16 in. in diameter and one 14 in. These are the main steam lines described at the beginning of this article.

The plant is under the general supervision of Rix R. McDavid the operating superintendent. John A. Dondero is chief engineer with Richard H. Richardson, assistant chief engineer, in charge of the boiler room and Walter E. DeWaal control room engineer in charge of the heating system. Burns and Roe, Inc., were consulting engineers on the boiler plant and steam distribution system and Baker, Smith & Co. designed the heating system. Henry C. Meyer, Jr., of Meyer, Strong & Jones, Inc., was a member of the board of design on the housing project and the board's adviser on mechanical engineering work.

Protective Lighting of Industrial Plants

By H. E. MAHAN
Manager, Illuminating Laboratory
General Electric Co., Schenectady, N. Y.

INDUSTRY today is faced with many major problems. Among these is the matter of protection against sabotage. This form of malicious interference with industrial operations takes many forms, both from within and without an organization. To safeguard a plant from outside interference it is necessary to keep unauthorized persons off the property, and means to this end have been adopted by plants engaged in defense production. Such safeguards must operate throughout the 24 hr. of the day and obviously at night must be supplemented by proper lighting if daytime effectiveness is to be maintained.

To provide satisfactory lighting at a minimum of expense and the maximum of dependability requires a study of individual plants and conditions. The basis for such studies, however, are well established and the rules which experience has set up are sufficiently flexible to apply to practically any set of conditions. An attempt is made in this article to state these fundamental rules and to outline the practice very commonly followed in applying them.

The first consideration in lighting an industrial property for policing purposes is to select and locate light sources so that the vision of those responsible for protecting the property is aided and that of the intruder handicapped. Similarly, the guard should be concealed and the would-be trespassers made visible. Translated into terms of light, glare, if present, should be directed toward the person attempting to enter, and screened from the guard responsible for detecting him. Any shadowed areas caused by buildings, trees, etc., should be eliminated and supplementary light in the form of a searchlight under the control of the guard should be provided to permit him to investigate suspicious actions inside and outside the property. All lighting equipment and wiring should be a sufficient distance back from the fence line to make it difficult to be damaged and made inoperative by malicious persons. Needless to say, the illumination level should be adequate for the purpose and the circuit should be independently and conveniently controlled from a central point.

In considering the lighting requirements from the standpoint of the guard and the intruder, it must also be remembered that lighting satisfying these conditions may still cause glare to pedestrians and motorists along bordering streets and highways, or interfere with railroad or marine operations if railroads or navigable waters are adjacent to the plant. These are matters which require study on the ground and a satisfactory solution to avoid complaint.

The exterior lighting of industrial properties for policing purposes is usually accomplished in one or both of two ways. One method consists of providing an illuminated zone paralleling the boundary fence and extending both sides of it, and the second method treats the entire property as an area to be generally illuminated. Fence lighting systems may employ pendent luminaires or floodlight projectors and the manner of installing them

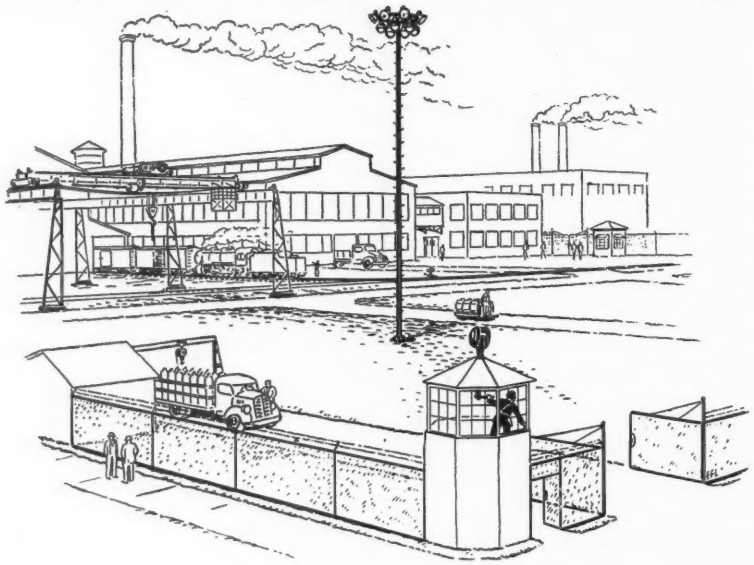


Fig. 1. Towers supporting groups of floodlights on pendent luminaires offer a practical means of lighting large areas. Searchlights under control of the guards provide supplementary light where needed

Fig. 3. One method of protective lighting is the illumination of the fence or property line with pendent luminaires at the top of poles set within the fence. Here is one illustration of this type of lighting at a large eastern industrial plant

follows the practice indicated in Fig. 2. The floodlight system (Fig. 2A) usually entails lower installation and operating costs and has proven very effective where conditions are favorable for its use. The pendent luminaire, equipped to deliver an asymmetrical light distribution with the maximum candle power parallel to the fence has many advantages from the standpoint of minimizing glare in situations such as previously mentioned. The pendent system of lighting also lends itself to series operation with the advantage of low copper costs and an independent centralized control. The practice followed in installing these units is outlined in Fig. 2B.

Regardless of the system employed, underground distribution and internal wiring of the poles is advisable in that these offer greater difficulty to persons attempting to black out the system by cutting the conductors. For the same reason poles supporting the lighting units should be located 20 ft. to 30 ft. inside the fence. Poles may be steel, concrete or wood and 20 ft. to 30 ft. in height. Wood poles in this range of heights favor low cost, but steel and concrete lend themselves best to concealed wiring and present a better appearance. Many plants, because of the arrangement of buildings, permit bracketing of luminaires and floodlights on the buildings and thus make unnecessary the use of poles.

Convenient and safe means of servicing the systems referred to above are essential. Where an avenue on the property parallels the lighting circuit a tower wagon can be used to good advantage; at other locations a ladder rest on the pole will enable an extension ladder to be used by the maintenance crew.

The second method or that of illuminating large areas is most effectively and economically done by means of groups of floodlights or pendent luminaires (Fig. 3) supported on high towers centrally located with respect to the areas to be lighted. If the power requirements warrant it, primary service may be carried to the tower and a transformer placed either on the tower or in a vault at the base of the tower to step the voltage down to that required for the lamps. Towers for this class of lighting will vary in height from 50 ft. to 75 ft. depending upon the area served. In general the lighting requirements are satisfied by providing lighting equipment equivalent to 0.1 to 0.25 watts per sq. ft. of area.

Whether floodlights or pendent luminaires are best suited for a particular location is not always obvious as there is no sharp line separating their respective fields of application. The floodlights may be placed a greater distance away from the area to be lighted than pendent luminaires and this is frequently an advantage because of limitations in tower locations and accessibility of power supply. Where towers may be spaced not exceeding 300 ft. apart pendent luminaires will be found to provide better distribution and less likelihood of shadows in areas utilized for material storage. Pendent luminaires used for this purpose should deliver a symmetrical distribution of light and be equipped to confine the light in the lower hemisphere.

Supplementing the general illumination of the plant, it is advisable to place under the control of the guards a searchlight which will permit investigating suspicious actions inside and outside the plant. Such a searchlight should be maneuverable from within the guard house (Fig. 1) and for average conditions be at least 18 in. diameter and equipped with a 1500 watt lamp of appropriate type depending upon the nature of the beam required and the average hours of service.

Light is a necessary adjunct to all other means of police protection and the manner of its installation should be co-ordinated with these other measures.

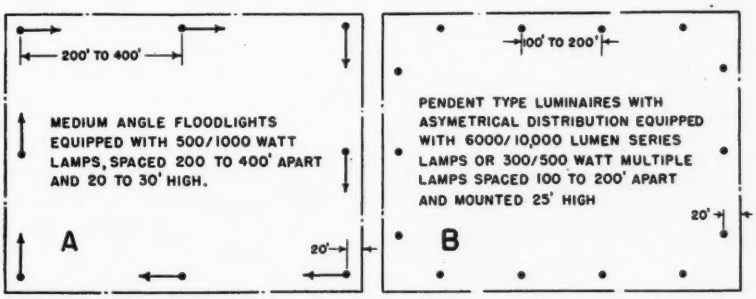

200' TO 400'
MEDIUM ANGLE FLOODLIGHTS EQUIPPED WITH 500/1000 WATT LAMPS, SPACED 200 TO 400' APART AND 20 TO 30' HIGH.
A
20'
100' TO 200'
PENDENT TYPE LUMINAIRES WITH ASYMETRICAL DISTRIBUTION EQUIPPED WITH 6000/10,000 LUMEN SERIES LAMPS OR 300/500 WATT MULTIPLE LAMPS SPACED 100 TO 200' APART AND MOUNTED 25' HIGH
20'
B

Fig. 2. Methods of lighting property lines for police protection. (A) By means of floodlights. (B) By means of pendent luminaires

DAMPER CHARACTERISTICS

For well over 2 yr. we have had in our confidential files these test data primarily for reference in the recent series of articles on Combustion Control Specifications and for correlation with meager field tests available. As far as we know, this is the first comprehensive investigation that has been made, the results are of extreme importance to the industry and we are pleased to be able to present them to our readers. The importance of the dampers as vital control elements is not generally appreciated, the relation of the damper to the entire draft system is not well understood and the lack of knowledge of damper capacities and characteristics among engineers is appalling. These points were well covered by the authors in presenting the subject before the Atlanta Meeting of the A.S.M.E. but due to lack of space only that portion of the data relating to fundamental damper characteristics is presented below. A later article will deal with damper design and the relation of the damper to the system

By P. S. DICKEY[1] and H. L. COPLAN[2]
Bailey Meter Co.

IN SPITE of the universal use of dampers as a means of controlling air gas flow for furnaces of all types, there are but scant published data covering the design of these devices. In boiler practice, prior to the introduction of mechanical-draft fans, the primary consideration in damper design was to avoid any pressure loss, and thus reduction in capacity, when the damper was wide open. To achieve this end, the dampers were usually made quite large, and the tendency has been to follow this practice without any thought as to their regulating characteristic.

Since dampers are usually of considerable size, it is not ordinarily practicable to build them as precise mechanisms, but this is entirely unnecessary. Dampers of simple and inexpensive construction and with quite reasonable clearances can be built to give good regulating characteristics for manual or automatic control if a few fundamental considerations are followed.

The misapprehension which too often exists among designers and users of dampers is that, because a specific damper has given good results in one application, it will likewise give good results in all applications. Efforts have frequently been made to standardize damper design and size for definite capacities, but the results are not always satisfactory for reasons which become obvious when further study is made of the problem.

For the purpose of the studies described, it was felt that models 12 in. square or of equivalent area would give reliable results and a blower was provided which would give velocities up to 5000 f.p.m., which is as high as ordinarily encountered in furnace work. Twelve different damper types were tested and, of these twelve, nine have been selected as representative types. The characteristic curves and design details are included in Figs. 1 to 9.

The beginning of real progress in this investigation came with the realization of two factors of extreme importance in damper design: the gas velocity through a given damper has no material effect on the flow characteristic if the total resistance of the system exclusive of the damper is unchanged; and the flow characteristic of a given damper is variable and is determined primarily by the ratio of its resistance at any given opening to the resistance of the system in which it is installed.

It becomes obvious that a given size and type of damper in a specific system will have a fixed flow characteristic regardless of the maximum gas flow. Therefore, if means can be provided for calculating the resistance of different types of dampers and if the total resistance of the system in which the damper is installed is known in advance, the flow characteristic of a given damper in that application can be predicted.

Damper-Design Characteristic Curves

Information covering the various damper types was obtained and the data plotted on the typical damper characteristic sheet, shown in Fig. 1, which covers the single-leaf damper. The flow of course depends on the design features; area characteristic; combined approach factor and coefficient of discharge and resistance ratio. The principal features of design are shown in the sketch in the corner of each curve. Factors which have an important bearing on the flow characteristic of the specific damper design are tabulated in the caption.

The area characteristic of each specific damper type is shown by its corresponding Curve A. Curve A gives the area at any position as a percentage of the net open area of the damper frame. The net open area is, of course, the gross area of the damper frame minus the cross sectional arch of the damper blades when wide open. This information was obtained as accurately as possible on the model tested, but, obviously, will be affected somewhat by variations in the manufacture of a given type of damper. The combined approach factor and coefficient of discharge is given for each damper by Curve C as the flow coefficient, C. This coefficient was determined by calculation from the test data in accordance with the equation

$$C = W \times 124.3\ A_d\ h^{1/2} \quad . . (1)$$

where

- C = combined approach factor and coefficient of discharge
- W = pounds of air per hour at 80 deg. F.
- A_d = open area of damper at any given position, sq. in.
- h = damper differential, in. of water

[1]Director of Research.
[2]Research Department.

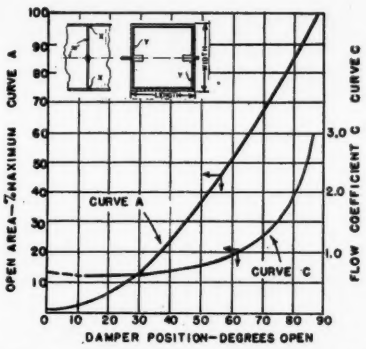


Fig. 1. Single blade damper in rectangle duct, without stops, with thin blade and with close clearance. X—side clearance equal to 1/4 per cent of duct width (per side). Y—end clearance equal to 1/4 per cent of blade length (per end)

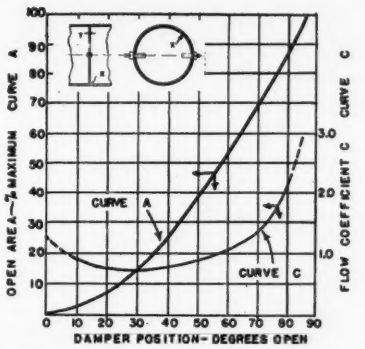


Fig. 2. Single blade damper in round duct, with thin blade and with close clearance but without stops. X—clearance equal to 1/4 per cent of housing internal diameter. T— thickness of blade equal to 1 per cent of housing internal diameter

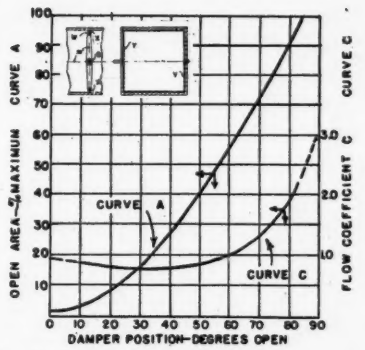


Fig. 3. Streamlined single blade damper. X and Y clearances equal twice Fig. 1, i.e. 1/2 per cent. W—diameter of blade ends equal to 2 1/2 per cent of blade width. S—center shaft diameter equal to 5 per cent of blade width

This information is plotted as Curve C in the lower right-hand corner of each curve.

Prediction of the Flow Characteristic

Prediction of the flow characteristic of the damper in a specific application is a relatively simple procedure with these data available. Knowing the maximum gas or air flow in cubic feet per hour, and the type and size of the damper to be used, the pressure loss across the damper may be obtained from the equation:

$$h = \left(\frac{Q\, d^{1/2}}{457.7\, C\, A_d} \right)^2 \quad \ldots\ldots (2)$$

where

h = damper pressure loss, in. of water

Q = gas flow, c.f.h.

d = gas density at existing temperature, lb. per cu. ft.

A_d = fraction open area times the open area of the damper frame in sq. in. The open area of the damper at desired damper position, d, (in degrees open from the closed position) is found from Curve A for the proper damper. This value expressed as a fraction (not a percentage) is multiplied by the net open area of the damper frame in sq. in. to give the value of A_2 to use in the equation.[3]

C = combined approach factor and coefficient of discharge at the desired damper position. Taken from the damper characteristic Curve C for the correct type damper and the desired damper position.

It will be noted that, in making this calculation, two different values are required from the damper characteristic curves covering the particular type being studied. Most accurate results are usually obtained by determining the pressure loss at damper openings from 20 to 40 deg. Therefore, a damper position should be selected between these values and, from the damper characteristic curve, the C value and the percentage of open area of the damper are obtained. Knowing the size of the damper, the maximum free opening can be determined and actual open area at the selected opening can then be calculated.

In furnace work, usually the system pressure loss at maximum gas flow is known and, in any case, it must be determined in order to predict the flow characteristic of the damper. It should be remembered that the system pressure loss means the total pressure loss from a point of constant pressure to the inlet of the fan or other draft-producing means. For example, a boiler furnace with forced and induced draft fans and a furnace draft control consists of two complete systems. One of these, the forced draft system, consists of all ducts and heat-transfer surface from the forced-draft fan discharge to the furnace.

Discussion of Types Tested

Figures 1 to 9 show the design characteristics of the various types tested. It is believed that most of the types in general use are covered. The conclusions reached regarding the relative merit of the various types are as follows:

The single-leaf damper in a round or rectangular duct is a thoroughly practical design and, if built with clearances not exceeding 0.25 per cent of the duct width, as well as properly sized to the job so that its resistance at 30 deg. opening is not less than 55 per cent of the total system resistance, a good flow characteristic is obtained. A damper of this size will have a low loss at the wide-open position.

Addition of side stops to dampers of single-leaf construction, as shown in Fig. 4, decreases the leakage without materially affecting the flow characteristic, assuming that the damper is properly sized as outlined. If side stops are used and the damper is properly sized to the job, the side clearance may be increased from 0.25 per cent of the duct width to approximately 2 per cent, as shown in Fig. 5, without materially affecting the flow characteristic. However, if the damper is oversize for the job, the increased side clearance will have an adverse effect on the flow characteristic.

A streamlined damper blade, as shown in Fig. 3, reduces the pressure loss at the wide-open position slightly, but not enough to be of any great importance. The flow characteristic of this design is not materially different from the flat-blade louver, and either will give good results if properly sized. The particular model tested had somewhat greater clearance than other types investigated, since it was felt that this damper could not be held to the same manufacturing tolerances. The leakage at low rates is therefore correspondingly higher. Side stops on this type of damper

[3]Note that the curves were drawn using the net open area, i.e., the opening of the damper frame less the area of the damper in its open position. In a subsequent communication, however, Mr. Dickey advises that in cases where he has had occasion to calculate dampers, he finds that the difference between net area and area of the frame is so slight that the error introduced by using the area of the frame is small indeed compared to other factors in the calculation over which one has no control. It is, therefore, his practice to use the area of the frame in making calculations.

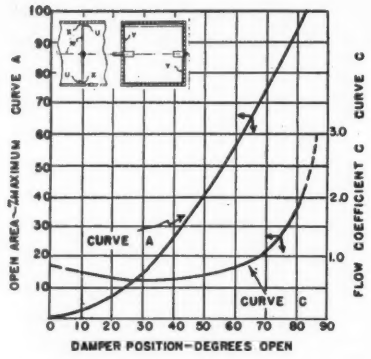


Fig. 4. Single blade damper with small clearance and side stops. X and Y clearances, ¼ per cent as in Fig. 1. U—side stops carefully fitted to damper blade for tight shutoff—with the seal extending 2 per cent of the blade width from the edge of the blade

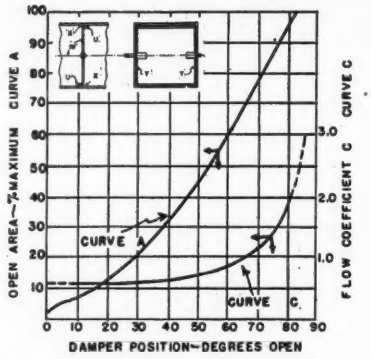


Fig. 5. Single blade damper with large clearance and side stops. X—side clearance equal to 2 per cent of duct width (per side), or four times that of Fig. 4. Y—end clearance equal to ¼ per cent of blade length (per end). U—side stops and seal as in Fig. 4

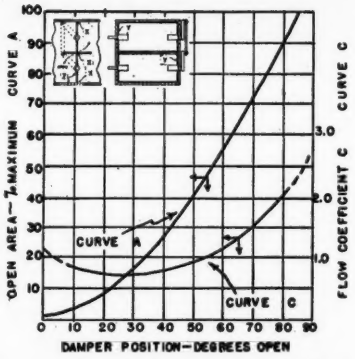


Fig. 6. Multiple leaf damper with dividing plate and close clearance. X—side clearance equal to ¼ per cent of duct width (per side of each blade). Y—end clearance equal to ¼ per cent of blade length (per end). Z—blade closed at right angles to duct

would reduce this leakage without materially affecting the flow characteristic.

Multiple-leaf-louver dampers, of the types shown in Figs. 6 and 7, give good regulating characteristics, although it is much easier to obtain a good regulating characteristic with the damper having divided partitions between the louvers than with the type which does not have the dividing partition. To obtain an equivalent flow characteristic, the damper without the dividing partition must be appreciably smaller, which may in some cases result in increased draft loss in the wide-open position. The characteristics of the model with the dividing partition could be improved by the use of side stops, which would reduce the leakage in the closed position. If these side stops were added, the flow characteristics would be similar to those in Fig. 4.

Butterfly dampers having cast frames and cast butterflies, as shown in Fig. 8, have a satisfactory flow characteristic if properly sized to the job. These units can usually be made to close quite tightly in view of the rigidity of the frame and of the butterfly.

Radial-vane-type dampers, of the type shown in Fig. 9, will give good flow characteristics if properly sized, though most dampers of this type are oversize, which result in a very poor flow characteristic. If the damper is made small enough to obtain a reasonably straight flow characteristic, there is likely to be some pressure loss at the wide-open position. This type of damper has its maximum effective opening at about 65 deg. travel, so that there is no occasion to use greater travel than this in an effort to obtain increased capacity.

Vanes can be made relatively tight closing if properly built and if arranged to overlap slightly in the closed position. From the standpoint of flow characteristic alone, this type of damper is not as desirable as the other types described but, since it is used primarily for the purpose of directing the gas flow into the inlet of the fan, the advantages gained thereby probably offset the disadvantages as a regulating device. It would appear that, with proper attention to the sizing of the fan inlet and thus the vanes, a reasonably good flow characteristic could be obtained without sacrificing pressure loss. One difficulty, of course, is the necessity for using different-size fan inlets for each installation.

A general conclusion is reached that most of the difficulties with dampers are due entirely to a lack of proper selection of size for each application, principally because information was not available to the designer.

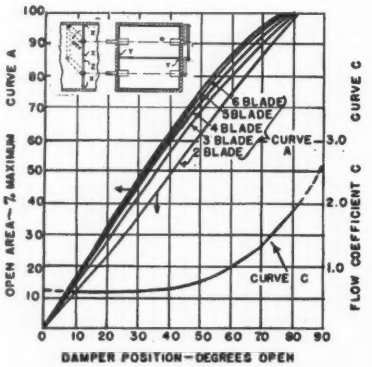


Fig. 7. Multiple leaf dampers without dividing plates, thin blades, close clearance, no stops. X, Y and Z as in Fig. 6. The clearance X between blades is equal to the clearance adjacent to the duct. Thus if X = ¼ per cent the total clearance = ¼ (No. of blades + 1) per cent duct width

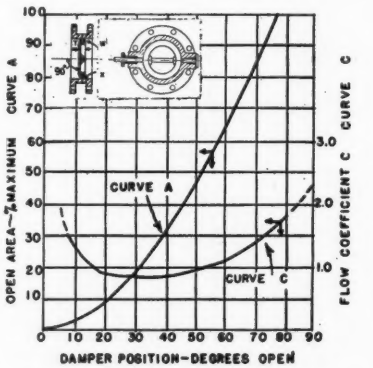


Fig. 8. Streamlined butterfly damper. Butterfly closes tightly against housing at X. Thickness of butterfly, T, equal to 17 per cent of housing internal diameter. Outside edge of the butterfly at W is rounded at a radius of 6 per cent of the housing internal diameter

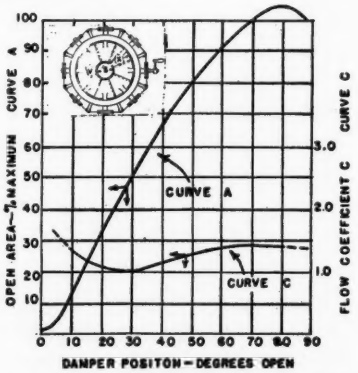


Fig. 9. Radial vane damper, multivane with blades overlapping. X—clearance between blade and housing and blade and hub each equal to ¼ per cent housing internal diameter. Vanes overlap at V. Diameter of center section 5 equal to 25 per cent diameter of internal housing

Plans under way for adding two 7500-kw. units by 1942; unit design employed; extraction turbines for supplying central heating system; cooling tower for circulating water; deaeration in condenser hotwell; Iowa coal used in pulverized form; furnace completely water cooled; steam generated at 615 lb.

BOONE POWER STATION to Triple Capacity

By JOHN M. DRABELLE
Consulting Engineer,
Iowa Electric Light & Power Co.

DUE TO the rapidly increasing electrical load in the western territory served by the company, an addition to the Boone Power Station has been planned and authorized which will add to the present capacity of 6500-kw., 7500-kw. of additional capacity with room and certain provisions for an additional unit of 7500-kw. capacity. When the ultimate plan is completed in 1942, it will bring the installed capacity of the Boone Power Station to 21,500-kw. This additional capacity is, as heretofore stated, to meet the growing load in the western territory and also to have liberal capacity provisions for National Defense, industrial development and other demands that may be made upon the company's system in its western territory.

This new addition will conform with what is now termed "The Unit Design," namely, one boiler and one turbine, complete in itself with all of its associated auxiliaries. This all tends toward simplification in design, economy in space and equipment and in ease of operation. There is an old saying among mechanical engineers, "if it's complicated, it's wrong."

Features of Building

The building planned will consist of two sections: a turbine room with its basement 10 ft. below grade line, having a width of 52 ft., a length of 68 ft. and a height of 48 ft. from grade line to roof. The boiler room will consist of a basement 10 ft. below grade line, having a width of 46 ft., a length of 68 ft. and a height of 97 ft. above grade line. The turbine room will be served by a 30-ton crane, for the initial turbine installation and the future installation as well. The building will be fireproof throughout, built of concrete, structural steel and brick.

Present side track facilities will be extended to the south to a new coal pocket or track hopper for the unloading of dump bottom cars together with the necessary coal crusher, magnetic pulley for picking up tramp iron, conveyors and overhead storage bunkers of 400 tons capacity. The coal will feed from the bunkers through two automatic scales to the two coal pulverizers located in the boiler room basement.

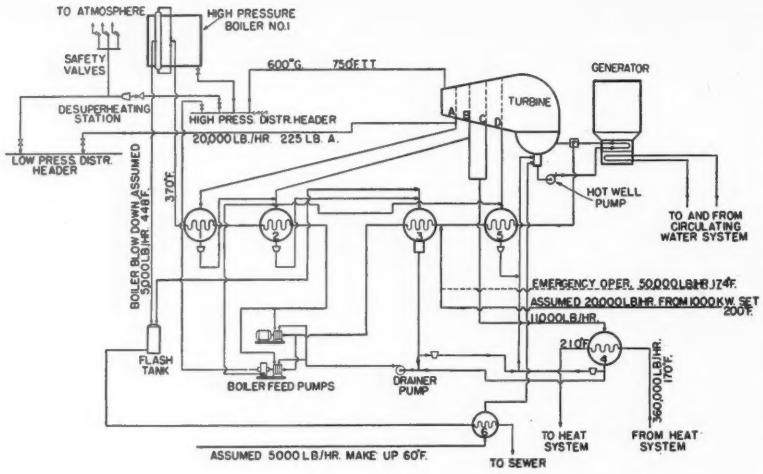
On account of the additional cooling water to be handled, a new cooling tower of the induced draft type will be constructed at the west end of the present spray pond. This unit will consist of eight cells, each cell having its own induced draft equipment. The total capacity of the new tower will be 130,000 lb. of steam loading and be able to cool the water to 85 deg. F. with a wet bulb temperature of 37 deg. F. This cooling tower will be so laid out that should future system demands require, a similar additional unit can be installed.

Steam Generation

Steam will be generated with pulverized coal, and all the equipment will be so designed as to make use of the coal mined in Iowa. The boiler will have a normal steam output of 125,000 lb. per hr. with a capacity for 6 to 8 hr. at the rate of 130,000 lb. per hr. The steam pressure at the superheater outlet will be 615 lb. ga. and have a total temperature of 750 deg. F. On account of the nature of the fuel used, the furnace will be completely water cooled and of the dry bottom type. Complete water cooling is necessary in order to avoid slagging and other troublesome and expensive operating conditions. The boiler gases, after leaving the boiler proper, will pass through an air preheater where the temperature of the air going to the furnace will be raised from approximately 80 deg. F. to 550 deg. F., part of this air going directly to the boiler for combustion purposes and part to the coal pulverizers or mills. The boiler will be fired by two pulverized coal burners with two mills, one for each burner. An oil torch will be used for "lighting off."

Piping, both steam and water, will conform to the Pressure Piping Code of the American Society of Mechanical Engineers. The high pressure steam line between the boiler and the turbine will be of carbon-molybdenum steel in accordance with the Code of the American Society for Testing Materials.

In the initial installation, the turbogenerator unit will be rated at 7500-kw., 2400 v., 3 phase, 60



Flow diagram for new Boone Power Station

cycles, 70 per cent power factor, operating at a speed of 3600 r.p.m.; at 83 per cent power factor the unit will develop continuously 9375-kw.

The turbogenerator will have its own direct connected and pilot exciter so as to stabilize the operation of the unit by means of high rate of response excitation when transmission lines are under lightning and storm conditions. The turbine will have four points of steam extraction. Three extraction points are used in the feedwater cycle and one for the central heating. For heating feedwater and for supplying steam to the older units in the station and under such condition, the unit will operate as a semi-topping condensing turbine, and one point of steam extraction at 20 lb. abs. which will supply steam to the present central hot water heating system for the heat exchanger supplying the central heating system. By providing this point of extraction, it will be possible for this unit to do all of the work which is now done by two units, namely, as a condensing machine and a central heat machine.

Cooling air for the generator and exciter will be passed through a surface air cooler, consisting of one section through which the condensate from the condenser passes, thus returning the generator and exciter losses as heat to the boiler feedwater, and an additional cooling section for cooling generator air when the condensate cooler does not absorb these losses. The return air from the exciters will pass through an air filter to remove all carbon and copper dust from the brushes and commutator.

Exhaust steam from the turbine will be condensed in a two-pass condenser, having 9500 sq. ft. of condensing surface. The tube material will be in keeping with the latest American practice, namely, phosphorized Admirality metal.

Circulating water will be supplied to the condenser from the new cooling tower and the existing pond system by two half capacity circulating pumps so as to permit the shutting down of one pump during light load or cold water conditions and also to permit of the continuous operation of the unit at partial loads when a circulating pump must be repaired. The condenser will also be furnished with two full capacity hotwell pumps so as to secure a high continuity factor of operation of the turbine unit.

Three special features of the condenser will be of interest: (1) that it will be welded to and a part of the exhaust casing of the turbine, thus eliminating the usual expansion joints and spring supports, (2) the shell will be of copper bearing steel welded throughout, and (3) the hotwell of the condenser will have a capacity of 1500 gal., using the condenser hotwell as the station surge tank. This hotwell is also a part of the boiler feedwater system which will be described later.

Two boiler feed pumps will be provided, one motor driven pump (normally operated) and one steam turbine driven pump for starting up and emergency use. Illustrative of the work done by the boiler feed pump, it will be capable of lifting a column of water 2045 ft. in height and deliver 300 gal. per min. at that head.

The boiler feedwater system is the heart of the entire extension for the reason that boiler water when at a pressure of 600 lb. per sq. in. is an entirely different performing water than the water in a teakettle on a stove or in a low pressure boiler. Owing to the fact that the Boone station does not supply any industrial steam, the amount of make-up water to the boiler can be kept at a very low percentage of the total pounds of water fed to the boiler. This, therefore, permits taking advantage of some of the latest advances in the central station art in America by making the hotwell of the condenser oversized, keeping all of the stored boiler water under high vacuum and free from dangerous and corrosive oxygen and carbon dioxide; and by bringing make-up water for the boiler into the condenser, spraying and flashing it, then removing all of dissolved gases in the water.

The feedwater cycle from the time the steam condenses until that water reappears in the boiler as water is of interest. The water or condensate as it is termed in power plant parlance, is pumped from the condenser by the condensate pump or to borrow a word from our British friends "the removal pump" and then forced through the condensate section of the generator air cooler, thence to the inner and after condenser sections of the steam jet air removal pump which is exhausting the air and other non-combustible gases from the condenser by means of a steam jet to the atmosphere.

When the turbine exhaust pressure is at 1 in. absolute, which corresponds to a steam exhaust temperature of approximately 80 deg. F., the water leaving the air removal apparatus is then at a temperature of approximately 86 deg. F. At this point it enters the first heater of the regenerative heat cycle equipment of the turbine, and steam is bled to this heater from the turbine, heating the water to approximately 185 deg. F.

On account of the fact that it is necessary to keep down certain chemical substances that accumulate in the boiler, water is bled from the steam drum of the boiler, commonly termed blow-down water, this water being at a temperature of almost 500 deg. F. This water passes through a regulating valve, and then comes to a flash tank operating approximately at atmospheric pressure. About one-fourth of the water blown down flashes into steam, this steam or vapor passes

to another heater, through a tube bank in which the condensate from the hotwell pump is passing. This steam then condenses and gives up its heat to the water en route to the boiler. The remaining water or liquid in the flash tank passes to another heat exchanger where it gives up its heat to the treated water going to the condensing hotwell, thus assisting, by this increase in temperature, the freeing of this water from the objectionable gases dissolved in it.

After leaving the vapor condenser, the water then passes to the boiler feed pump where its pressure is raised from approximately 20 lb. to 675 lb. to go on to the boiler. En route to the boiler, it encounters another heater in the regenerative cycle where steam is again bled from the turbine, and the water leaving this heater is then at a temperature of approximately 280 deg. F. It then passes to the last high pressure heater where more steam bled from the turbine again increases its temperature to approximately 370 deg. F. whence it passes to the boiler drum.

As previously mentioned, the turbine is equipped with four points of steam extraction. Three are used in the regenerative feedwater heating cycle, and the fourth point is used to supply steam to the heat exchanger for heating the central heat circulating water.

Under normal operating conditions, the turbine will pass through its throttle approximately 90,000 lb. of steam per hr. When heating the central heat water, this flow will increase to approximately 104,000 lb. per hr., and when operating as a semi-topping turbine and supplying steam to the low pressure units in the station, this flow will increase to approximately 126,000 lb. per hr. or stated in another way, about 53 tons of steam will flow into the turbine every hour.

On account of increasing the electrical generating capacity in the Boone station far beyond that for which it was originally designed back in 1911, it will be necessary to make extensive changes in the present switch gear to increase the rupturing capacity of the oil switches, so that under storm lightning and short circuit conditions the switches can safely open the circuit to which they are connected.

These improvements which have been planned for Boone will make the Boone station second to none in the state in continuity, safety, reliability and economy of operation.

DIESEL PUMPING UNIT

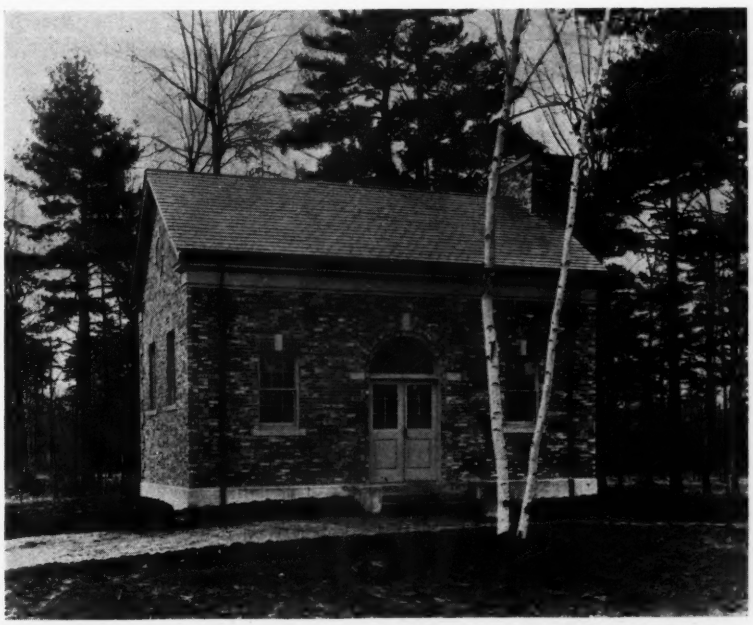
Small municipally owned deep well pumping plant at Needham, Mass., employs Diesel engine with automatic control to drive turbine pump through spiral bevel gears

By Francis A. Westbrook

AN EXCELLENT example of the advantages and technique of small Diesel-powered municipal pumping practice is to be found in Needham, Mass. This city, due to the need of increased water supply, faced the proposition of a tie-in with the Metropolitan Water Supply at a cost of some $300,000 unless some other, less expensive, means of taking care of the situation could be found. The problem was solved at a fraction of that sum by the discovery, after numerous test bores, of a good additional supply of water and the installation of a Diesel engine to drive a deep well turbine pump, with full automatic control obviating the necessity of a constant attendant.

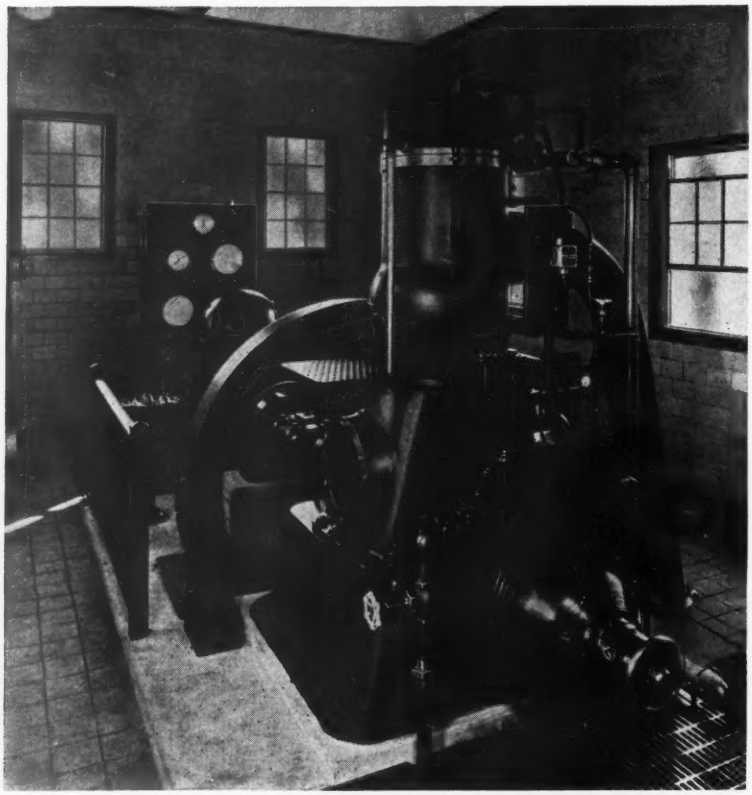
This very compact installation is housed in the small, neat building shown in one of the illustrations, and the pumping outfit itself is shown in another. It consists of a 75-hp. single cylinder, Fairbanks-Morse, Model 32 Diesel engine, and a 12-in. deep well turbine pump of the same make. It is rated to deliver 350 g.p.m. against a total head of 305 ft., or 700 g.p.m. against 270 ft. In this installation the total head is 272.5 ft. The lower bowl of the pump has been installed in a gravel packed well 40 ft. below the surface of the ground.

The engine employs the full Diesel principle operating on two-cycles, direct airless-injection of fuel. To save fuel, crank case scavenging is employed without the use of a separate pump as the action of the piston in the crank case provides the necessary pump-



Courtesy Fairbanks, Morse & Co.

Fig. 1. Architecture of Needham Diesel pumping plant harmonizes with beauty of forest surroundings



Courtesy Fairbanks, Morse & Co.

Fig. 2. Single-cylinder, two-cycle Diesel unit driving vertical turbine pump

ing function. Lubrication is also completely automatic and the governor controls the speed at all loads. Another important feature of design of the Diesel used here, and one having an equally important bearing on making it possible to do away with constant attendance, is the simplification resulting in the elimination of all moving parts in so far as practicable. This eliminates many adjustments and reduces maintenance to a minimum.

However, the detail which makes constant attendance unnecessary is the automatic safety control system, made by Automatic Safety Control Co., San Antonio, Texas. This provides for shutting down the engine automatically in case of overheating and also in case of loss of oil pressure.

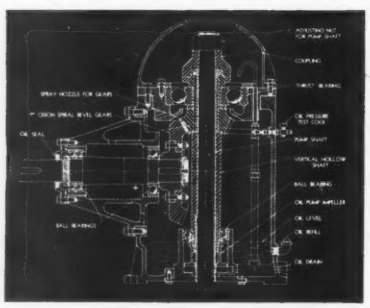


Fig. 3. Cross-sectional view of right angle vertical shaft drive

An interesting feature of the installation is the vertical speed transformer, made by Farrell-Birmingham, which transmits power from the Diesel through spiral bevel gears to the vertical shaft of the turbine pump, and also steps up the speed from the 300 r.p.m. of the Diesel to the 1190 r.p.m. of the pump. The top of this speed transformer is shown in the background of the photograph of the interior of the pumping station, Fig. 2, and in cross-section Fig. 3. The vertical shaft is hollow and designed to provide against deflection due to torsional stress. All bearings are of the anti-friction type and the whole unit is lubricated by a pressure system. The hollow shaft also permits adjustments of the pump shaft without disturbing the gears, and a coupling between it and the gears permits it to rise slightly without damage to the gears in case of a heavy up-surge.

The Fairbanks-Morse turbine pump is provided with a housing and shaft of sufficient length to permit its lower bowl being placed 40 ft. below the surface where there is no danger of the supply of water giving out. This is a 13-stage, 8-in. pump, so designed as never to need priming.

The Diesel engine is equipped with an exhaust silencer which has proved to be satisfactory. Starting is accomplished by means of a Fairbanks-Morse air compressor.

The cost of the equipment for this installation was around $13,000 not including the cost of the small building housing it.

Performance records show that the fuel cost of pumping 1,000,000 gal. against a head of 272.5 ft. at the rate of 702 g.p.m. is $3.95; and that pumping the same quantity against 309 ft. at the rate of 350 g.p.m. the fuel cost is $5.85. The cost with the old motor-driven station was $35. Consequently the latter is reserved for standby service.

Cooling Lubricating Oil

HEAT EXCHANGERS for cooling lubricating oil commonly use water as the cooling medium. While this medium is usually the most convenient it is not always the best. In many cases heat exchangers can be advantageously adapted to use mineral lubricating oil as the cooling medium. This is especially helpful as stated in a recent issue of Lubrication published by The Texas Co., in service where leakage might impair the lubricant, as would be the case in steam turbine service where water leaks would cause emulsification and rusting. Even though oil cooling may not give as much cooling effect as water the advantage is distinct and the arrangement should be given consideration.

In the case of Diesel engines heat transfer is directly related to lubrication. Where the cylinder walls and pistons are directly exposed to burning gases, lubrication of these surfaces must be carried out under most detrimental conditions and well refined straight mineral oils possess quite satisfactory characteristics as heat transfer media. They have but little tendency to gum or develop heat resisting deposits, and should leakage develop the quality of the lubricant in the crankcase will normally not be materially lowered, especially if the oil which is used for cooling is of a sufficient degree of purity.

COMBUSTION-GAS TURBINE in the Power Field

Development of materials for high temperatures and of efficient axial compressors has enabled engineers to make practical and economical application of long known thermodynamic principles in the generation of power by the expansion of furnace exit gases through a turbine

AMONG the developments in the field of power generation during recent years, none stands out more prominently than does the gas turbine. For over 100 yr. the thermodynamic principles upon which present equipment works have been known and appreciated by engineers who have studied the problem. Several developments were necessary, however, before these principles could be put into practice. Now that these developments have taken place, gas turbine power generating units are being built and the results secured in operation have been so encouraging that in all probability these units will find an important place in the power generating field.

In this country, the principal application has been in the oil refinery field where in the Houdry process large volumes of air are required to re-activate a catalyst by burning off coke and carbon deposits in regular intervals. This operation is carried out at a pressure of 45 to 50 lb. per sq. in. and the resulting combustion gas, issuing at a temperature around 950 deg. F. is expanded through a turbine to generate the power to drive the compressor.

While the development originated in Switzerland where the Brown-Boveri Co. did a vast amount of experimental work and built a number of units which are now in successful operation, units of this type are being built by Allis-Chalmers Mfg. Co. which has carried on development work in the United States. One of the developments being studied is the application to the railway locomotive. The present progress of this development work was outlined recently by J. L. Ray of the Company's Steam Turbine Department before the Chicago Section of the A.S.M.E. He described the basic principle of the unit as a process of generating hot gas at elevated pressure and expanding it through a turbine.

Essential Elements of Gas Turbine

The present successful form consists of a rotary axial flow compressor delivering air under pressure to a combustion chamber where it is heated by direct combustion of fuel, passing thence to the turbine inlet. The turbine drives the compressor and any machine to which it may be coupled.

Two major limitations were faced by the gas turbine pioneer, lack of materials suitable to withstand the temperature and stress imposed on the combustion chamber, the turbine wheel and the blading, and lack, more especially, of a rotary compressor of the necessary efficiency, which must be high.

For a gas turbine to develop enough power to drive its compressor and have a surplus left for useful work, there is a minimum value for the combined efficiency of turbine and compressor, that is, the product of the turbine efficiency and the compressor efficiency, corresponding to the allowable turbine inlet temperature. Thus, with the low combined efficiency of the early turbine compressor set, the necessary turbine inlet temperature was very high, higher than can be used even with present day materials.

For some years, highly efficient turbines developed for steam power plants have been available, but only comparatively recently has there become available, as an outgrowth of aerodynamic research, an air compressor of comparable efficiency. Progress in steam turbine metallurgy also now permits a considerable advance in operating temperatures.

As a result, gas turbines which will operate at full load thermal efficiencies as high as 17 per cent at the coupling are now commercially available. This can be attained, moreover, without exceeding by more than 50 or 100 deg. F. standard steam turbine operating temperatures.

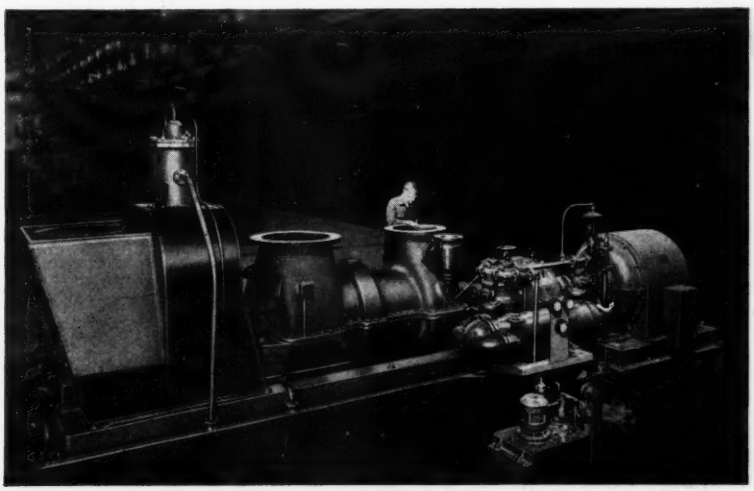


Fig. 1. Gas turbine-axial blower unit set up for test. Blower rated at 40,000 c.f.m., 45 lb. gage pressure, 5180 r.p.m.; 6660 hp. turbine; gear connected to 1500 hp., 1800 r.p.m. generator

*In the preparation of this article liberal use was made of data secured from Allis-Chalmers Mfg. Co. and statements made in a paper by Dr. J. T. Rettaliata of the Steam Turbine Department of that company and presented before the A.S.M.E. under the title of The Combustion-Gas Turbine.

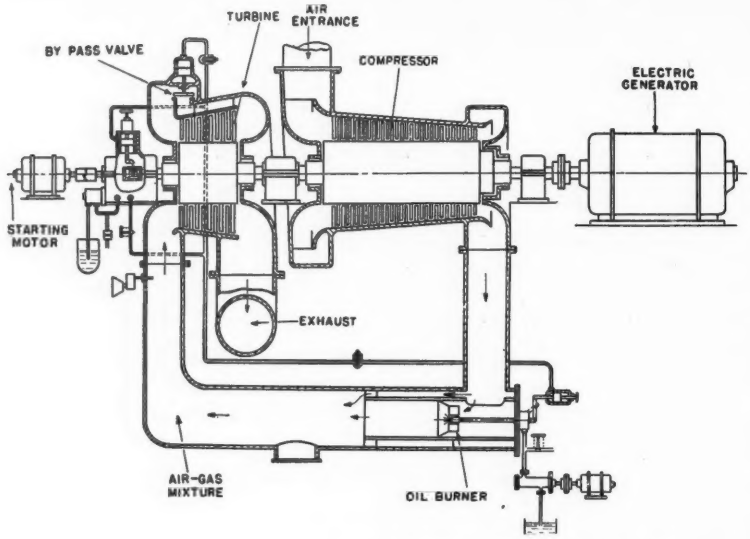


Fig. 2. Diagrammatic arrangement of gas turbine-axial blower electric generating unit

These turbines are of the simplest type, having neither exhaust heat recovery nor intermediate reheat between turbine stages. The addition of a reasonable amount of heat recovery surface alone will raise the efficiency to between 20 and 25 per cent. When the present search for materials and local cooling methods is successful to the extent that 1500 deg. F. inlet temperature is permissible this figure will become about 30 per cent.

At present a considerable number of gas turbines are in actual commercial operation. This includes over 80 units serving Velox pressure combustion boilers, over 16 oil refinery units, a 4000-kw. generator unit in a standby power plant and a 2200 hp. locomotive scheduled to have been in operation last fall in Switzerland. Experience with these commercial jobs has been satisfactory.

The gas turbine may be expected to inherit the high standards of performance that have been established for the steam turbine. In stationary power plant practice, turbines are expected to operate continuously over long periods of time, from 12 to 24 months without maintenance interruptions.

Gas Turbine Described

Shown in Fig. 2 is a diagrammatic drawing of a modern gas turbine-axial compressor unit. A 5-stage reaction type gas turbine is directly coupled to a 15-stage axial compressor. Air from the atmosphere enters the compressor where its pressure is raised. Part of the air discharged from the compressor is used for combustion purposes in the oil burner; the remaining air flows through the annular space and cools the products of combustion to a satisfactory turbine inlet temperature. The gas, a mixture of air and combustion products, then expands through the turbine from which it is exhausted to the atmosphere. The power developed by the turbine is greater than that required by the compressor and the excess power is supplied to the generator. In order to start the unit from a standstill, a motor is provided to bring the unit up to about 25 per cent of the normal speed at which point the turbine is capable of driving the compressor.

The unit is controlled by a speed governor connected to the fuel oil supply. In this way the inlet gas temperature to the turbine is varied, thus changing the power developed by the turbine. An emergency governor actuates a bypass valve around the turbine when a designated overspeed is exceeded. The turbine and compressor are connected through a solid coupling which enables their equal axial thrusts to neutralize each other, thus eliminating the necessity of balance pistons.

In Fig. 3 is shown a view of a partially assembled gas turbine-axial compressor unit with the top half of the casing removed. This unit is rated at 23,000 c.f.m. of air at standard conditions. The turbine at the left is mounted on a common bedplate with the compressor at the right. In addition to the elements shown in this picture, the complete simple plant consists of the electric generator, combustion chamber, fuel controls and a lubrication system.

Thermodynamic Cycle

By referring to Fig. 4, which represents the theoretical Brayton

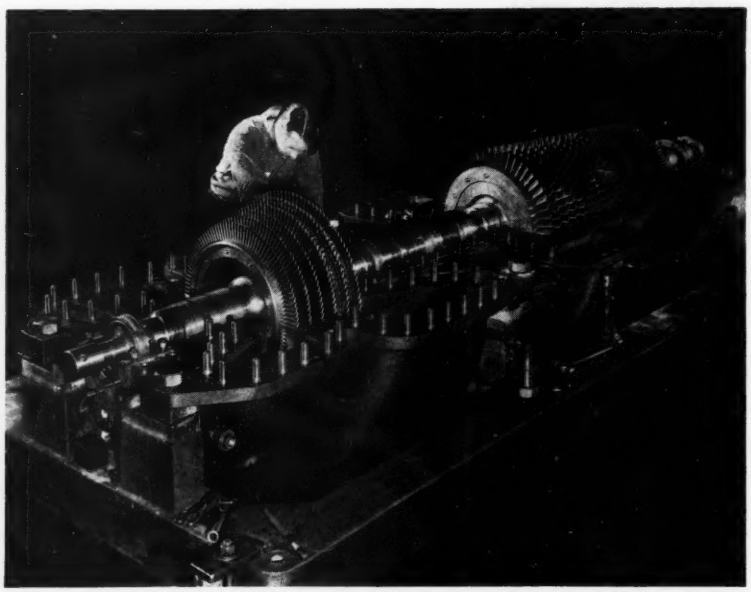


Fig. 3. View of 23,000 c.f.m. gas turbine-axial blower unit with top half of casing removed. From left to right along the shaft the elements shown are: emergency governor; overspeed trip mechanism; turbine shaft bearing; labyrinth sealing gland; turbine inlet opening; six rows reaction blading; turbine exhaust opening; labyrinth sealing gland (not visible); shaft bearing; shaft coupling; shaft bearing; labyrinth sealing gland; compressor intake; 21 rows of blading; discharge opening; labyrinth sealing gland (not visible); shaft bearing; shaft coupling for attachment to power driven element

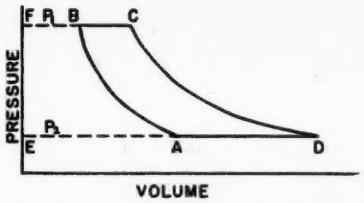


Fig. 4. Pressure-volume cycle of gas turbine-axial compressor unit

cycle upon which the gas turbine operates, it will be seen that the isentropic compression in the compressor is represented by AB. The isobaric combustion of fuel is shown by BC. Line CD depicts the isentropic expansion in the turbine. The assumption of a closed cycle requires that the exhaust gas be cooled along the constant pressure line DA. The energy theoretically required to compress 1 lb. of air in the compressor is represented by the area EFBA. The energy liberated by 1 lb. of gas expanding in the turbine is shown by the area EFCD. Consequently, the difference between these two areas, ABCD, would be the theoretical excess energy available for power purposes.

The temperature-entropy plane may also be employed for the purpose of demonstrating the cycle as shown in Fig. 5 where typical conditions are indicated on the chart. Here the exhaust gas is discharged at 612 deg. F. into the atmosphere. Such a loss of energy naturally hinders economical operation. One of the various methods by which the thermal efficiency of the gas cycle may be improved is by the use of a heat exchanger. In this manner the exhaust gas from the turbine may be utilized in raising the temperature of the air discharged from the compressor. Efficiencies may be further increased, as shown in Fig. 6, by reheating the gases after they have expanded through part of the turbine in a manner similar to the reheating of steam.

Calculations indicate that, with inlet temperature at 1022 deg. F. and air intake at 68 deg., the thermal efficiencies range from a peak value of 16 per cent when no heat exchanger is used, to 24.5 per cent obtainable with a heat exchanger having a surface of 30,000 sq. ft. Peak efficiencies occur at various pressure ratios in the compressor for different heat exchanger surfaces.

For every given turbine inlet temperature there is one compressor pressure ratio for which the overall thermal efficiency of the unit will be a maximum, as shown in Fig. 7. For the purpose of comparison, the curves are based on the assumption of no pressure drop existing between the compressor discharge and the turbine inlet. An examination of the curves will disclose that approximately a linear relationship exists between turbine inlet temperature and pressure ratio for the realization of maximum efficiency. The sensitivity of the cycle to temperature is effectively displayed by a doubling of thermal efficiency when the temperature is increased from 600 to 800 deg. F.

Although none of the gas turbines so far built by Allis-Chalmers has been designed for more than 1000 deg. F., the 1200 deg. F. curve in Fig. 7 indicates the possibilities of projected development.

The overall thermal efficiency of the theoretical cycle is a function of pressure ratio for various efficiencies of turbine and compressor. Increasing these efficiencies from 0.75 to 0.90, a 20 per cent change, results in a 400 per cent increase in maximum thermal efficiency obtainable, when the turbine inlet temperature is 1000 deg. F. Their trend will naturally be upward when future materials warrant safe operation at higher temperatures.

Excess power of the unit as a function of compressor efficiency for various turbine efficiencies is shown in Fig. 8. The curves are based on an ideal cycle with no regenerator and a turbine transmission temperature of 1000 deg. F.

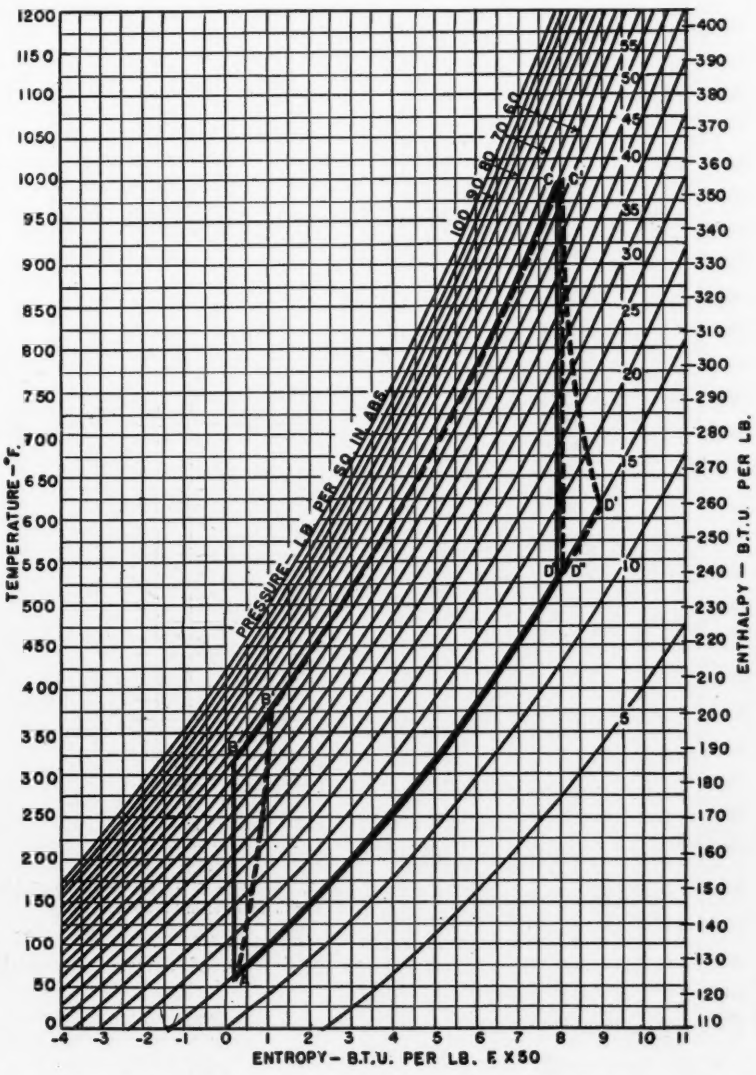


Fig. 5. Theoretical and actual cycles plotted on temperature-entropy diagram for air based on variable specific heats. Enthalpy scale is added for convenience

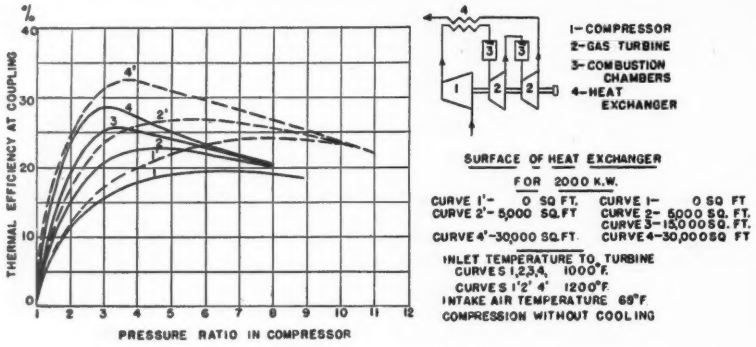


Fig. 6. Thermal efficiency of gas turbine calculated for cycle employing reheater and heat exchanger

A manifestation of the importance of high turbine and compressor efficiencies is presented by the curves. A 20 per cent increase in a turbine efficiency of 75 per cent entails a 300 per cent increase in excess power with a compressor efficiency of 75 per cent.

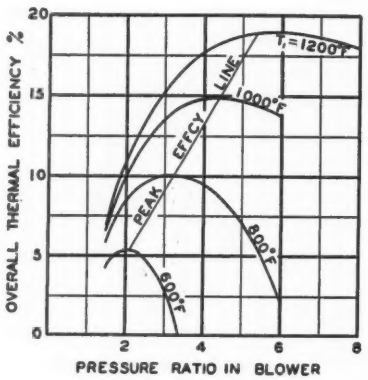


Fig. 7. Variation of overall thermal efficiency with change in pressure ratio in blower

Although the gas turbine unit has been a long time in coming, it has now passed the purely experimental stage and is being offered in competition with other well established power generating units. The low pressure at which it operates—40 to 45 lb. per sq. in.—makes the problems of construction simple. At present the fuel which is applicable to this unit is gas or oil, but there is some experimental work going on in Europe in the use of pulverized fuel which, if successful, will widen the applicability of the unit. It is reported that no difficulties have been encountered with lubrication and it is expected that one charge should last for years, as it does with steam turbines. As the unit does not in any way depend upon water, feedwater difficulties are entirely eliminated. Changing atmospheric conditions will affect the power output to a considerable degree, particularly temperatures and barometric pressures. It has been pointed out that the gas turbine must develop approximately four times as much energy as that which it delivers as excess, which fact takes it out of competition with large steam turbines. With development of design and materials to permit higher temperatures, moderate size units should find economic application in the field of power generation.

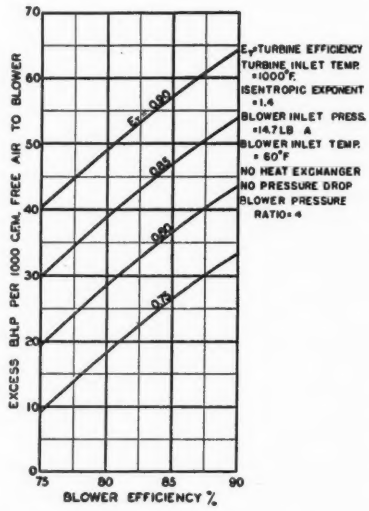


Fig. 8. Variation of excess power available with changes in blower efficiency

Oil for High Speed Gas Engines

SELECTION of proper lubricating oil for the modern gas engine is recognized by the Gas Engine Power Committee of the American Gas Association as of the utmost importance if the wear on moving parts is to be reduced to a minimum, thus insuring long engine life and low maintenance costs. The difference in the actual cost of the lubricating oil, between the higher and lower grades of oil, is relatively small due to the low lubricating oil consumption, according to a recent report of the Committee. The advent of package power (high speed multi-cylinder engines as over and against the older large bore, long stroke, slow speed, horizontal types) brought difficulties. Insofar as oil is concerned, the principal difficulty which arose was the increase in oil temperature due to high velocity rates of circulation and also the limited capacities of lubrication systems. The problem of ring sticking has not been serious. The principal difficulty encountered, the Committee found through investigation, has been to control the rate of thickening of oil.

This oil thickening may be traceable to oxidation, rather than polymerization or precipitation of unsaturates due to sulphur compounds generated in the oil, has been borne out by the fact that changing to oils which had higher inherent stability characteristics, plus the addition of some agent to enhance the stability, seems to have been the answer to some of the difficulties.

For the high speed multi-cylinder gas engine, the Committee is of the opinion that SAE 30 or SAE 40 oil should be used, depending somewhat upon the operating temperature of the engine. The viscosity of the SAE 30 oil is between 51 and 68 Saybolt Universal seconds, and the SAE 40 oil is between 57 and 74 Saybolt Universal seconds, at 210 deg. It is also believed that an oil should not be used after the viscosity has reached 100 Saybolt Universal seconds. For the heavy duty, slow speed engine, it is advisable to conform to the recommendations of the engine builder as to the type of oil, as they are based upon a number of years of operating experience.

CYLINDER FRICTION AND LUBRICATION

The second of three articles. The first on bearing lubrication appeared in the April issue, this article deals with steam and Diesel engine and air compressor cylinder friction, and the third will discuss lubrication requirements of gears

By VERNON M. HUFF

WHEN ONE body slides over or along another, the sliding of the first is resisted by the second. The component resistance of either in its total reaction along the surface of contact is called friction. In a more general way, friction may be called a passive force which comes into action only when two bodies are in sliding contact. Friction increases as slippage increases and it acts in opposition to the moving force.

Bearing surfaces of every kind of machine, however operated, require lubrication to prevent wear and loss of power which would result through frictional resistance between rubbing surfaces. The power loss through frictional resistance is converted into heat, which in fast running machinery may be generated sufficient to melt and destroy the rubbing surfaces. Lubrication not only reduces the frictional resistance between rubbing surfaces but it also reduces the heat being generated, by the introduction of new oil which acts to cool the bearing, thus making it possible to operate high speed engines and machinery for unlimited periods.

Friction is divided into three classifications: rolling friction, sliding friction, and fluid friction. This article deals only with sliding and fluid friction. Sliding friction is the resistance between two bodies sliding one upon the other as shown in the illustration.

This friction is caused by the roughness of the sliding surfaces. The surfaces may be ground and polished, yet under a powerful magnifying glass they will be seen to have small hills and valleys which when the two surfaces are placed together, fit into each other as shown in the illustration. When the one body slides over the other, these hills and valleys through rubbing contact become worn and flattened down. In this action a resistance to their movement is brought about, the amount depending on the pressure and the roughness of the surfaces.

When a fluid moves in contact with solid surfaces, a resistance is set up due to the motion of the fluid in its body. A layer of lubricant will adhere to the surface of a cylinder and have no motion. The next layer, however, will have motion and the velocity of the succeeding layers increases as the thickness is increased. These layers of lubricant constitute the film between the sliding surfaces of the bodies. The flow is faster and has less resistance in its center area than at the point where it is in contact with the surfaces of the bodies. It is in this area that fluid friction becomes operative, creating friction in the lubricant rather than with the two sliding surfaces. The property which the particle or molecules of the fluid possess for adhering together is called viscosity.

Fluid Friction

Fluid friction is not affected by the nature of composition of the bearing metals, but by their degree of smoothness on the surface. The purpose of using lubricating oils on cylinders, bearings, gears, etc., is to reduce the friction between the moving bodies, and transfer it to the lubricating body. A perfectly lubricated surface should follow the laws of fluid friction. However, it has not yet been possible to obtain perfect lubrication. In certain types of machines and under certain operating conditions, perfect lubrication is closely approximated, but in the majority of cases such as pressures, moderate and high speeds, the friction is partly fluid and partly metallic or sliding.

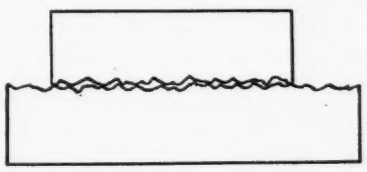
Lubricants are divided into semi-solid and viscous fluids. The semi-solids contain compounds of animal and vegetable fats with petroleum oils. The liquids contain compounds of animal, vegetable, and petroleum oils. Petroleum mineral oils are by far the largest requirement used in plant lubrication. Petroleum mineral oils are composed of hydrocarbons and are known as volatile oils.

When the petroleum crude is taken from the ground it is composed of a mixture of hydrocarbon compounds ranging from gas to solids. Through distilling processes by heat, the parts of the petroleum separate and by further refining or distilling, each of the parts produces additional hydrocarbon compounds. It is due to these properties and the distilling processes that so many different products are obtained from petroleum.

Approximately 80 per cent of the crude stock is distilled into products other than lubricants. It is the remaining 20 per cent from which lubricating oils are obtained. The processes of distilling are continued to produce the types of oils desired.

Characteristics

The flash point of an oil is the temperature at which it will give off vapors in sufficient quantities to allow of their ignition by a flame. The fire point is the lowest tem-



Friction is carried by and is proportional to the degree of roughness of the sliding surfaces

NOTE: On p. 58 of the April 1941 issue, Part I of this series, Fig. 2 shows the position of the shaft in a bearing; at rest; starting and in running position. In the center figure, showing the shaft starting with counter clockwise rotation, the clearance is shown on the wrong side. Starting from rest the shaft will first climb the bearing a short distance in a clockwise direction before being lifted by the oil film over to normal running position.

perature at which an oil will take fire, and may be 10 to 75 deg. F. above the flash point of the oil until the oil reaches the burning or fire point. It is of great importance that an oil never be used in places where it may be subject to temperatures above its flash point.

Further, the nearer the temperature of an oil approaches its flash point, the less its lubricating value. Engine oil for instance should never be used on steam valves or cylinders. The temperature of steam at 210 lb. ga. is about 390 deg. F. and engine oil loses its lubricating value at a much lower point. Steam cylinder and valve oils do not lose their lubricating value under 500 deg. F., and many high grade oils go to 700 deg. F.

Engine Lubrication

The amount of oil required for steam cylinders depends on the size of the piston and the speed of the engine. It has been found that 1 pt. of cylinder oil will lubricate approximately 1,500,000 sq. ft. of surface passed over for 10 engine hr. The formula most commonly used is developed from this and in round numbers is:

$$P = \frac{B\,S\,R\,T}{575{,}000}$$

where

P = pints
B = bore in inches
S = stroke in inches
R = r.p.m.
T = engine hours operation

Thus for a 14 by 22 in. engine operating at 155 r.p.m. for 10 hr. the amount required would be

$$P = \frac{14 \times 22 \times 155 \times 10}{575{,}000} = 0.83 \text{ pints}$$

Transposing the equation gives a direct solution for the number of engine hours for a given quantity of oil. Thus for 1 pt.

$$T = \frac{575{,}000\,P}{BSR} = \frac{575{,}000 \times 1}{14 \times 22 \times 155} = 11.9 \text{ hr.}$$

The most economical application of steam cylinder oils yet developed is believed to be that applied by an atomizer. The atomizer, of which there are several makes and types, is a device for atomizing or breaking the oil into very small parts, by the use of steam from the main steam line where it enters the instrument through a condenser pipe. The surge and velocity of the mixed condensate, steam and oil forces its way through a mixing and atomizing tube containing floating baffles which churn the mixture into an emulsion.

Thus the oil is broken up into very fine particles, after which it is returned to the steam line where it flashes into steam once more. The atomized oil remains in suspension in the steam where it is carried to the valves, cylinders and pistons. Steam deposits the atomized oil on the moving surfaces providing a uniform lubricating film on all exposed parts and effecting economy of application.

Diesel Engines

In the Diesel cylinder, air is compressed to a high pressure until the heat of compression is sufficient to ignite the fuel oil. Contrary to other types of internal combustion engines, the Diesel will not operate for any considerable time if any operating part or adjustment is not exactly as they should be. They must be kept in constant good condition with no loose pistons and rings, no bad valves and no deposits on valves or rings, nozzles cannot operate in a clogged condition and exhaust ports must be kept free of deposits, etc.

One of the reasons for the slow development of the Diesel engine has been lubrication, and this is still a major problem in some types, particularly in the high speed and automotive fields. Diesels are constructed in two types, commonly called two cycle and four cycle engines. The two cycle engine makes two piston strokes in each power stroke and the four cycle engine makes four piston strokes in each power stroke. Combustion takes place every two strokes on the two cycle and every four strokes on the four cycle.

Oiling systems of various Diesel engines differ in application. Cylinders receive oil from a mechanical lubricator, or they may be splash oiled, receiving oil thrown from the crank shaft. However, most Diesels employ mechanical lubrication for the cylinders, the oil being injected in one, two or more places. Proper lubrication of a Diesel cylinder requires a complete film of oil on the entire cylinder wall. With adequate distribution of the oil to the cylinder, it is spread by the piston rings which collect the oil on each stroke, and spread it as completely as possible.

Cylinders Hardest to Lubricate

The most serious difficulty in proper Diesel cylinder lubrication is the fact that the engine is a high compression unit, it is also a high temperature engine. The oil in each cylinder is exposed to the high temperature of 3000 deg. F. on each down stroke of the piston. However the complete destruction of the oil film is retarded somewhat by the cooling of the cylinder walls by water jackets and fast ac-

Operating and Lubrication Pointers for Diesel Engines

Part	Trouble	Result and Effect	Correction
Cylinders	Worn.	Deposits on rings. Stuck rings, increased wear. Blow-by, fuel contamination, stuck piston.	Proper lubrication. Proper oil. Adequate feeds.
Nozzles	Clogged up. Enlarged openings.	Poor injection. Deposits, improper combustion, stuck valves, low power. Sticking rings.	Check fuel, tanks and lines, replace if necessary. Renew injectors. Check fuel pump.
Valves	Deposits. Seats coated or warped.	Poor compression, loss of power, poor combustion, leakage, deposits on valves, stuck rings. Sludge in crank case.	Check lubrication and use correct oil. Check feeds. Replace bad valves. Clean guides. Check gravity of fuel. Check nozzles.
Piston rings	Worn. Clogged. Sticking.	Compression loss. Blow-by, oil loss, poor combustion.	New rings or new liners. Rebore. New pistons. Check timing and fuel. Check nozzles.
Ports	Obstructed. Deposits, poor scavenging.	Bad combustion, low power.	Clean exhaust ports. Check fuel oil.
Fuel system	Worn pump.	Worn plunger.	Clean, or if necessary, replace.
Cooling system	Rusty. Clogged with scale. Poor cooling.	Cylinder walls overheat. Oil film destroyed. Stuck rings, valves. Rapid ring wear.	Clean system thoroughly.
Operator	Improper knowledge.	Speeding up cold engine. Neglect of engine.	Skilled and experienced operator.

tion of the piston which quickly replaces the film on each stroke.

Difficulties come about by the high pressures exerted on the piston rings. This pressure is on the oil surrounding the rings and in the grooves of the piston. The oil must separate the rings and the wall, and must seal against blow-by of exhaust gases. These gases when allowed to enter the crank case contaminate the lubricating oil with a heavy carbonaceous material which deposits on the rings and in the grooves, soon causing the rings to stick. It also attaches itself to the exhaust valves, baking into a hard deposit causing sticking and poor seating of the valves with resulting loss of compression.

Oil film on the upper part of the cylinder wall becomes weakened and sometimes destroyed in spite of the cooling given the walls. The hot gases act on the oil in this area and it is here that wear is first detected. Diesel oils have properties to resist this heat. They have film strength to resist pressure and prevent blow-by. Most Diesel cylinder oils contain a detergent agent which acts to cut and wash down the carbonaceous material resulting from fuel oil gases. The detergent when present in an oil acts to prevent deposits on the rings and valves.

In engines which have become contaminated with deposits, extreme care is necessary with this type of oil in its first application. Frequent draining is necessary at short intervals, due to the loosening and washing down of the deposit material by the oil. It soon becomes contaminated beyond its useful stage, possibly resulting in clogging up filters or small lines causing a reduced flow to engine parts. However, this occurs only in the cleaning up process on an old engine or one which has become dirty from deposits.

Two or three drains, the first after about an hour of operation and the others at 200 and 500 miles respectively should result in effective cleaning of the engine, after which the oil may be used for far greater periods than ordinary or conventional type oils.

Oil Filters

Care should be taken to change filters with each oil change, both during the cleaning up process and after. The detergent compounded oils are also proving highly superior to conventional oils in heavy duty truck and bus gasoline engines, operating in long haul and extreme service conditions.

Deposits occurring in a Diesel engine may bring about a series of conditions, any of which can cause serious trouble. Spray nozzles become clogged, burner plates become coated, valves become caked with deposits, and fail to seat properly, rings become stuck in piston grooves, bringing early and excessive wear, allowing blow-by of gases, any of which or in series will result in loss of power and increases in operating costs.

Air Compressors

Air compressor cylinders vary according to operating conditions in one, two, three or more stages of compression. They operate in a warm or hot condition and are lubricated by mechanical lubricators with individual plunger feeds to each line. Only limited quantities of lubricating oil are required for proper lubrication of compressor cylinders. The oil is fed direct to the cylinder walls in one or more places and is distributed over the surfaces by the piston.

Discharge valves on a compressor are directly in the path of the heated air, and become the hottest part of the cylinder head. Extreme care is necessary to assure clean air entering a compressor. Dust is present in the intake air and its presence accelerates the formation of deposits in the cylinder and on the valves. The heat in a compressor cylinder is not sufficient to bring about a carbonization of the oil used in compressors, however deposits do occur from the dust in the intake air which settles on the exhaust valves where the oil acts as a magnet for attracting and holding the dust.

Heavy bodied oils should never be used in compressor cylinders. The heavier the oil, the greater the tendency to attract and hold foreign matter in deposits. Deposits interfere with valve action allowing recompression of air which brings about an increase in temperature which may reach above the flash point of the oil in the cylinder, or for that matter far above the flash of any lubricating oil.

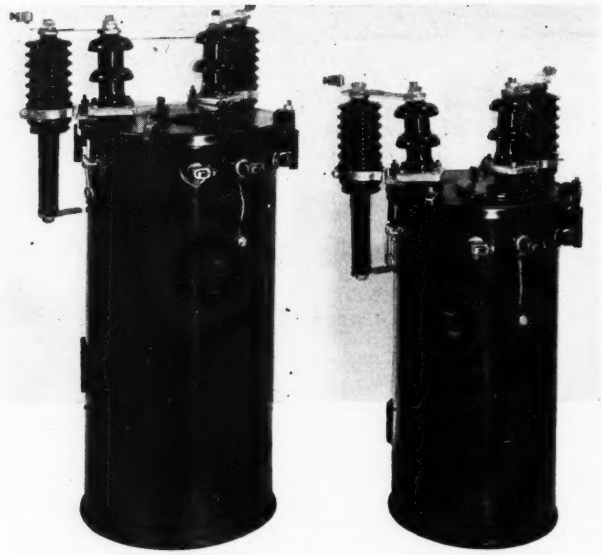
Unstable and poor grade oils break down rapidly in compressor service, the oil requirements vary between a one and two stage, and between the three or more stage compressor. Regardless of the stages of compression, the air retains a high moisture content. This moisture in the air traveling at high velocity in the cylinders has a washing effect on the oil film, frequently destroying its efficiency altogether. This results in blow-by between piston rings and the cylinder. Rust occurs on the valves and rings from the moisture, resulting in rapid wear from abrasion.

Compounded oils, that is mineral oils, containing a compound of vegetable oil have been found to give the best results in resisting the washing effect of the wet air. The efficiency of the compounded oil is due to its greater tenacity and ability to adhere to the parts with a protecting film against wear and rust. High grade straight mineral oils are suitable and satisfactory for pressures up to 150 lb. For the three and four stage compressors and wet conditions for any number of stages, a compound oil is preferable.

Carbon Monoxide

Operators of Diesel engines have been warned by the National Safety Council of the poisonous effects of the carbon monoxide in the exhaust fumes of Diesel engines. An incident was reported in which the operator of a Diesel operated tractor, equipped with a sun umbrella, was apparently overcome by carbon monoxide fumes from a leaky manifold on a day with little air movement and extremely high humidity. It is possible that the fumes were pocketed under the umbrella. Men operating cab equipped tractors are frequently affected by headaches, so it is reported, but are never bothered on open machines.

While Diesel operated engines under normal operating conditions only produce a fraction of the carbon monoxide of gasoline operated engines, from available information, excessive oil injected while accelerating, or improper adjustment or sticking of valves can result in excessive production of carbon monoxide fumes. Gasoline engine exhaust averages about 7 per cent carbon monoxide, producing it at the rate of 1 cu. ft. a minute for 20 hp. rating. Concentrations of 0.06 per cent of carbon monoxide will produce severe symptoms in two hours,—headache, nausea, dimness of vision, vomiting, etc. This may be followed by unconsciousness, depressed heart action, and possibly death.



Showing the difference in size between Hipersil Distribution Transformers (Right) and a conventional unit

HIPERSIL Improves Transformer Design

By H. V. PUTMAN
Manager, Transformer Division
Westinghouse Electric & Mfg. Co.
Sharon, Pa.

ONE OF THE newest offsprings of industrial research is Hipersil, an improved magnetic material which, used in transformer cores, has one-third greater flux-carrying capacity than the best conventional silicon steel. In carrying this increased flux it requires no more magnetizing force and its losses will be no greater. Furthermore, its magnetostriction, or sound-producing property, is reduced so that increased magnetic flux causes no increase in sound level. In its first application it has reduced size and weight of distribution transformers as much as 25 per cent; has facilitated reduction of copper losses some 10 per cent and thereby increased short-time overload capacity.

A crystal of any magnetic steel is cubical in form; is easily magnetized along its edges, less easily along its diagonal. If these molecules could be packed face to face like toy building blocks in a tray, the material would be easily magnetized in any one of six directions. Such a steel would be perfectly "grain orientated." Ordinary silicon steel has little or no grain orientation, but the special process of producing Hipersil results in orientation in one direction (that of rolling); hence the material is easily magnetized in this direction.

Its flux-carrying capacity in this direction is almost one-third greater than that of conventional hot-rolled silicon steel, but used at right angles to the grain it would be much less effective than the older material.

Under a magnetizing force a piece of steel elongates, then contracts when the flux collapses. Elongation depends on the strength of the magnetic field. With an alternating flux, as in a transformer, this dimensional change takes place twice each cycle; so the core is a structure that changes in size continually. These mechanical vibrations are transmitted through transformer oil to tank wall, then to surrounding air, thereby resulting in transformer hum. Though the movement is extremely small—only about 12/100,000 in. for a core 4 ft. long—the resulting noise may be annoying in residential substations or industrial plants.

Known technically as magnetostriction, this cycle dimensional change in Hipersil is less than in ordinary silicon steel at the same flux density. Even at the higher densities at which Hipersil is utilized in transformers, magnetostriction is at most no greater, so transformer noise will not be increased as a result of greater flux density in the core. Should it be important to produce a transformer of unusual quietness, a relatively small reduction in flux density in the Hipersil core would produce the desired effect.

Makes Transformers Smaller, Lighter

Because Hipersil can be worked at higher induction than ordinary silicon steels, the size and weight

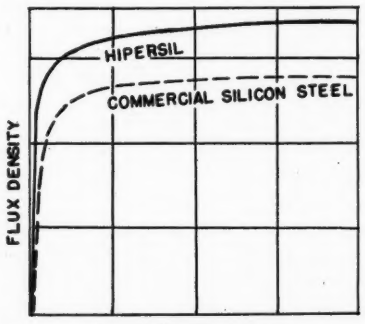


Fig. 1. Hipersil works at higher flux density than ordinary silicon steel because the knee of the saturation curve is about a third higher

of transformer cores can be reduced; consequently, fewer turns of copper are needed, and the average length of turn is diminished. This means that less iron, copper, and oil can be used, and that these components can be placed in a smaller tank. For distribution transformers weight reduction is from 20 to 25 per cent.

About the largest single-phase transformer that can be mounted on a pole is 75 kv-a. With Hipersil such a unit can be replaced by a 100 kv-a. transformer. Similarly, prevailing practice limits the size of three transformers hung on a single cross-arm to about 37½ kv-a. each, but this limit now can be easily increased to 50 kv-a.

Improvement in voltage regulation gives to the system operator more electrical capacity per dollar of investment. Normally energy must be supplied to the consumer at a specified maximum regulation; therefore, if the transformer can carry a larger load safely to reach a given voltage regulation, it has an increased useful capacity.

Greater flux-carrying capacity of the newly evolved material can be used by the designer in two ways to improve the voltage regulation. Shorter average length of turns in the winding, and consequently lower copper resistance, reduces voltage drop at unity power factor, while shorter mean turn and fewer number of turns gives lower reactions, which reduces voltage drop at low power factor. In general, incandescent lamps and heating appliances operate at unity power factor; motor-driven devices and fluorescent lights result in low power factor loads. Since the usual load comprises all types of devices, it is important to reduce not only resistance but also reactance so that regulation may be improved under all conditions.

In transformers rated at 15 kv-a. and less, voltage regulation has been improved, on the average, approximately 10 per cent at unity power factor and 12 per cent at 0.80 power factor. In larger sizes impedances are determined by short circuit considerations rather than by regulation, so in this range emphasis is placed on smaller weights and dimensions.

The simple magnetic circuit of a Hipersil transformer makes ventilation of the winding easy, so the temperature gradient between coils and oil can be reduced. Since copper losses for a given load are decreased, the quantity of heat generated in the winding is lessened, and a greater short-time overload can be carried without exceeding safe operating temperature. A typical distribution transformer using the new magnetic material carries 2¼ times full load for an hour, but an older transformer of the same rating carried only 1.9 times full load for the same period and same temperature rise.

During the last two decades distribution loads and load factors have increased steadily, because of the increasing use of major electrical appliances. In 15 kv-a. and smaller transformers using Hipersil, losses are adapted to these modern loads by lowering copper losses and increasing iron losses, so that their product remains essentially the same as in older transformers. As a result of these changes, the total loss in service is lowered; and as a result of lower coil temperature gradients the transformer is better able to stand the severe overload peaks imposed by large appliances.

The newly developed magnetic material benefits the transformer user in still one other way. Distribution transformer cores made from it are assembled in two pieces that can be taken apart easily for replacement of coils, if it becomes necessary.

One typical power company finds it uneconomical to repair a transformer smaller than the 10 kv-a. size, because labor costs offset savings. With the simplified Hipersil structure, it probably would be economical for the utility operator to keep a stock of spare coils and repair all transformers, regardless of size.

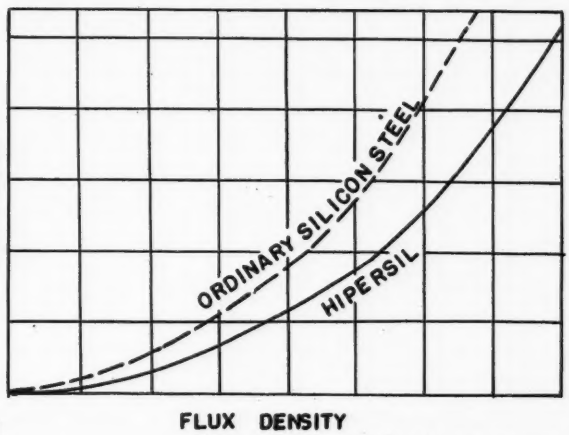


Fig. 2. Hipersil has lower loss than ordinary silicon steel at same flux densities. Losses are about the same when both work at their normal operating densities

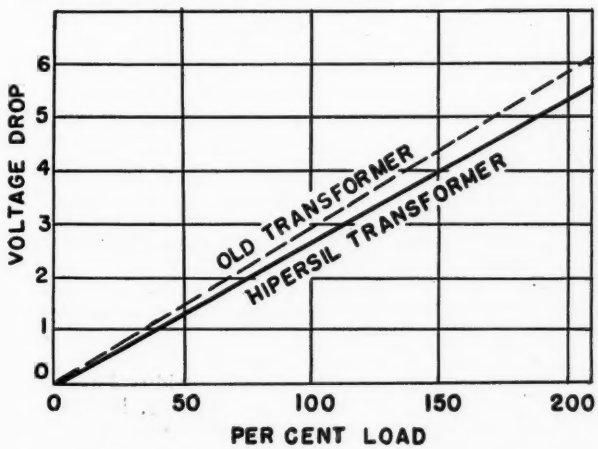


Fig. 3. Voltage regulation is improved by the new material, especially in smaller distribution transformers. These regulation curves are for 2400-v. 10 kv-a. transformers operating at 0.80 power factor

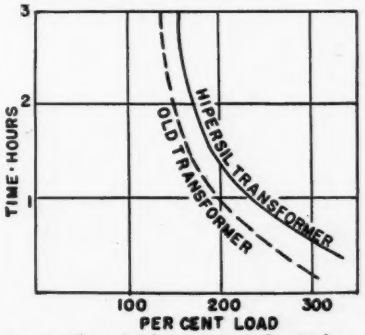


Fig. 4. These load-time curves for 10 kv-a. show that the new transformer carries roughly 20 per cent more load for a given time to reach a temperature rise of 55 deg. C.

Among the chemical impurities in water that have received increasing attention are hardness, alkalinity, silica and anions in general. The author discusses in this article the methods he and his associates have worked out and are using for conditioning water for industrial purposes. In a previous article, April, 1940, issue, he discussed the elimination of physical impurities

WATER TREATMENT For Chemical Impurities

By S. B. APPLEBAUM*

FOR THE LARGE high pressure boilers and for certain industries such as rayon and similar synthetic textile fibers, photographic film, plastics, etc., more complete removal of hardness is being emphasized. Sodium zeolite softeners have for some time been used for this purpose. Figure 1 shows the usual performance curve of a zeolite softener when the run is begun and ended to satisfy the usual soap test of 5 drops of Boutron & Boudet soap solution in 40 c.c. of softened water. A number of zeolite plants are using a more sensitive soft water soap test and Fig. 1 also shows the performance on that basis. The length of run is reduced by about 10 to 20 per cent, but the hardness of the effluent is nearer true zero, being under 0.5 to 1 p.p.m. throughout most of the run with raw waters of medium hardness. It has been observed in several high pressure boiler plants that this change in method of operating zeolite softeners has improved the cleanliness of the interior of the boilers, especially in the hottest tubes.

One of the future trends in this direction will be a series operation using a final second stage zeolite softener following a battery of first stage zeolite units. The last portion of the runs of the first stage units will thus receive additional zeolite treatment for scrubbing out practically all the hardness. By staggering the regenerations of the first stage units, the capacity of the second stage units can be kept to a fraction of the first stage.

*Vice President, The Permutit Co., from a paper delivered before the Engineers Society of Western Pennsylvania.

Alkalinity

The advent of carbonaceous zeolite has made alkalinity removal by zeolite possible. This type of zeolite can withstand acids and can therefore be regenerated by acid. Thus hydrogen zeolite is formed which removes alkalinity by exchange as follows:

$$\begin{matrix}\text{Ca}\\\text{Mg}\\\text{Na}_2\end{matrix}\Big] \cdot \Big[\text{HCO}_3\Big]_2 + \text{H}_2\text{Z}$$

$$= \begin{matrix}\text{Ca}\\\text{Mg}\\\text{Na}_2\end{matrix}\Big] \cdot \Big[\text{Z}\Big] + 2\text{H}_2\text{O} + 2\text{CO}_2$$

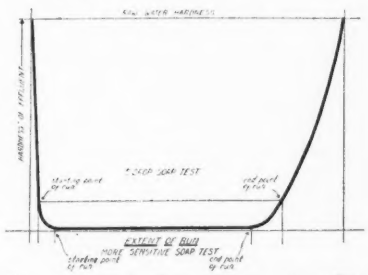


Fig. 1. Low hardness effluent of zeolite softener

Thus alkalinity is converted to CO_2 which is then mechanically removed by the degasifier.

Sodium bicarbonate, present in many well waters, is now for the first time made removable by this simple hydrogen zeolite process. Previously, the only known method of removing it (without increasing total solids) was by distillation.

An increasing number of hydrogen zeolite plants have been installed during the last few years for boiler plants and many industries such as raw water ice, carbonated beverage, textile plants, etc.

For surface waters a combination of Spaulding precipitators for coagulation or lime pretreatment followed by acid and sodium or hydrogen Zeo-Karb, have also received favorable acceptance. The lime pretreatment removes turbidity and other physical impurities and also reduces the alkalinity very efficiently. This is due to the effectiveness of the sludge blanket which not only causes a saving in lime but produces a water of lower carbonate hardness or Ca and Mg alkalinity than the old-fashioned lime treatment plants can accomplish.

This combination may also be used with slight modification to remove silica. The carbonaceous

zeolite which follows, being non-siliceous, then avoids silica pick-up from the zeolite.

Silica Removal by the "Mag-de-Sil" Process

Due to the increasing difficulties with silica scale in high pressure boilers and silica carryover and silica deposits in steam turbines, the Permutit Company's Research Department several years ago was instructed to investigate and devise a new and more economical method of silica removal than had previously been in use. The absorptive effect of ferric hydroxide was well known, but it was expensive and increased total solids excessively for waters of high initial silica content.

This investigation has been successful and the work is summarized in a paper by H. L. Tiger, Vice President in charge of Research, at the December, 1940, meeting of the A.S.M.E.

Briefly, the successful SiO_2 absorbents found were MgO or $Mg(OH)_2$, and the process worked out has therefore been called the "Mag-de-Sil" process. The investigation revealed the following major points:

(1) Ionic Mg precipitated in situ as $Mg(OH)_2$ is most efficient, but MgO or $Mg(OH)_2$ added in solid insoluble form is also very absorbent if fine particle size is employed and other conditions are fulfilled.

(2) Efficiency of SiO_2 removal increases with temperature.

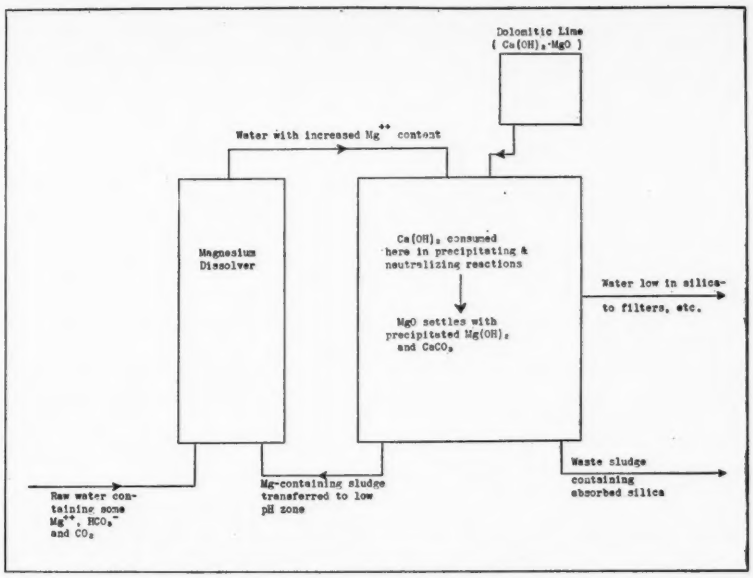

Dolomitic Lime
(Ca(OH)₂·MgO)
Water with increased Mg⁺⁺ content
Magnesium Dissolver
Ca(OH)₂ consumed here in precipitating & neutralizing reactions
Water low in silica- to filters, etc.
MgO settles with precipitated Mg(OH)₂ and CaCO₃
Waste sludge containing absorbed silica
Raw water containing some Mg⁺⁺, HCO₃⁻ and CO₂
Mg-containing sludge transferred to low pH zone

Fig. 3. Sequence of reaction in "Mag-de-Sil" process

(3) Efficiency increases with concentration of retained MgO or $Mg(OH)_2$ sludge in contact with the water.

(4) Long time of contact with the sludge absorbent in agitated suspension is essential.

(5) The contamination of the retained concentrated sludge by the SiO_2 absorbed must be kept within definite limits and therefore certain ratios of fresh MgO added to SiO_2 removed are to be observed.

(6) An efficient and economical source of MgO or $Mg(OH)_2$ is special dolomitic lime, where softening of the water by lime is also desired. Otherwise, special calcined magnesite (MgO) is economical.

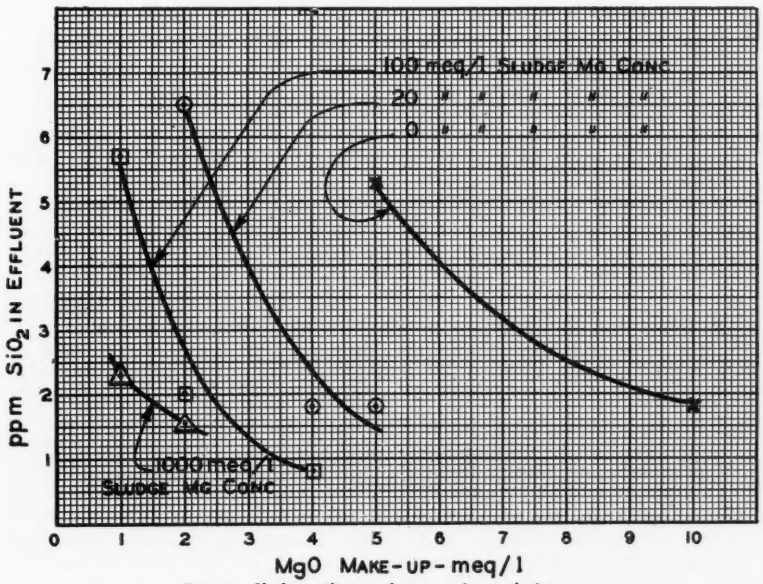


Fig. 2. Sludge, silica and magnesium relations

The curve in Fig. 2 shows the effect of increasing sludge concentration on decreasing the amounts of fresh MgO required for a definite SiO_2 content in the effluent and vice versa, i.e., decreasing the SiO_2 in the effluent for a definite dosage of fresh MgO. This diagram plots the results of work carried out at 95 deg. C. If the operating temperature is lower (say 20 to 25 deg. C.) the curves are even further apart so that the advantages of higher sludge concentration as provided by a Spaulding precipitator are still more pronounced.

Since it was found that the precipitation of ionic Mg gave the most efficient SiO_2 removal, a new method was devised for introducing the Mg from the dolomitic lime into solution. This consists of a two-stage process. The raw water with or without added CO_2 passes through the first stage, which is the Mg dissolver. The effluent then passes into the second stage which is the usual lime treatment Spaulding precipitator. The dolomitic lime is added instead of the usual high calcium lime into this second stage. The MgO in the dolomitic lime does not go into solution in this second stage because the pH value is too high. The sludge from the sludge blanket, containing the MgO in suspension, is recirculated to the Mg dissolver, where it meets raw

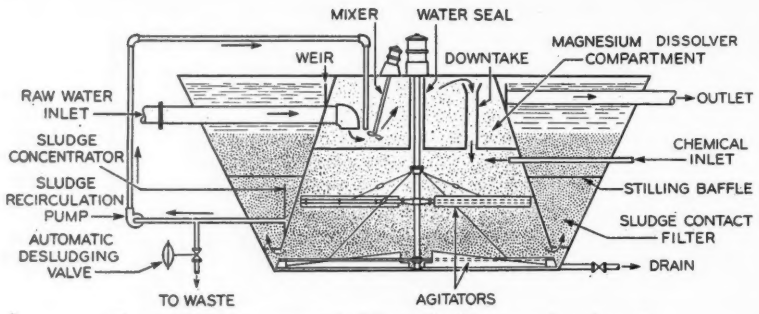


Fig. 4. Typical arrangement of Permutit silica removal equipment

water of low pH. The HCO_3 and CO_2 in this raw water, plus added CO_2 if desired, dissolves the MgO from the sludge. See Figs. 3 and 4.

Inasmuch as no sulfate or chloride is introduced in this process and the Mg is reprecipitated as $Mg(OH)_2$ and the HCO_3 and CO_2 are precipitated as $CaCO_3$ in the second stage, the SiO_2 removal takes place without increase in total dissolved solids.

A number of silica removal plants of this type are now in use and the process is receiving very favorable acceptance.

Anion Removal—De-Mineralizing Process

Hydrogen zeolite removes the cations, Ca, Mg, and Na, etc., quite completely. It also removes the anion HCO_3 by converting it to CO_2 which is then eliminated by the degasifier. The other anions SO_4, Cl, etc., however, are not removed.

A new Permutit organic material called "De-Acidite" has been developed and is now in successful use for anion removal.

This "De-Mineralizing" process is a two stage process. In the first stage the cations are removed by Zeo-Karb H, converting the salts present into their corresponding acids. The "De-Acidite" is then used in the second stage to absorb or remove these acids. The Zeo-Karb H is regenerated by acid and the "De-Acidite" by alkali, such as Na_2CO_3. The final effluent produced approaches distilled water in quality. An average analysis is as follows:

Total hardness expressed as $CaCO_3$	0 to 2 p.p.m.
Bicarbonates expressed as $CaCO_3$	3 to 8 p.p.m.
Chlorides expressed as Cl	2 to 8 p.p.m.
Sulfates expressed as SO_3	2 to 4 p.p.m.

This process is not applicable to remove salt from sea water, as has been sensationally forecast in popular scientific magazines, because its cost of operation would be excessive. But research work is still being continued to increase the efficiency and economy of the process, so that ultimately it may be applicable to remove total dissolved solids of up to 500 p.p.m. or more in the raw water.

Thus far the process has found application to replace distilled water in a number of industries, such as pharmaceutical and drug concerns, special plastics, mirrors and similar silvered products, special beverages, etc. The future trend that is already evident is the application of this process to boiler feedwater treatment for high pressure boilers.

INDUSTRIAL AIR CONDITIONING

Industrial air conditioning dates well back into the 1880's in one form or another and was well entrenched in many industries when it caught the popular fancy a decade ago. From a process standpoint, not all industries need air conditioning, but even the independent metal industry has found it of great advantage in special applications

By THAYER FRANCIS
Engineer, Parks-Cramer Co.
Fitchburg, Mass.

ONLY WITHIN the past 10 yr. has the general public become "air conditioning conscious," but many industries have reaped the benefits of one or more of its functions for several decades. The original industry, and still the largest user, to employ one of its fundamental features—humidification—was the cotton textile. The fact that most of the early cotton mills were built along power-yielding streams was not a matter of chance.

Nature gave them the wherewithal to run the mill and the natural dampness so necessary to the manipulation of the fibres to be treated. But, though the founders had sought an ideal location so far as dampness was concerned, the climate was such that, during winter, heat was necessary from a comfort and manufacturing standpoint.

Heat is the enemy of humidity, the more heat is applied to a given atmosphere, the lower will be the relative humidity. As time went on and manufacturing speeds were increased, still more power was used and the liberated heat from this power lowered humidity to the point where it was insufficient for good manufacturing. That is the story of why, even as far back as the 1880's, the art of humidification entered the New England cotton industry. For 50 yr., to a greater or less degree, the humidifying system has been an accepted part of a cotton mill. Without it, the continuous production of high grade fine cotton fabrics, for which New England mills are noted, would be either impossible or so costly as to find no market.

There is no exact history of the adoption of air conditioning by industry except the ledgers of its

sponsors. Most of those ledgers are defaced by time to such a degree that their perusal is difficult. Devices as they are known today did not exist and to designate the installation in a certain plant as air conditioning might cause serious dispute in the light of modern knowledge.

It is recognized, however, that tobacco probably succeeded textiles in becoming "humidity conscious." To that industry the art brought the ability to keep the tobacco leaf moist and supple during inspection, to dry the leaf and cure it under any selected atmosphere or weather, to insure that when the cigar or cigarette reaches the smoker it will be neither a "hot smoke" nor a soggy, unburnable mass.

With the exception of these two industries, there is no record of wide adoption of anything approaching air conditioning by industry until after the beginning of this century.

About 35 yr. ago, Walter Baker & Co., a Boston candy concern, installed a dehumidifying air conditioning system; not under those names, not with the scientific knowledge of the air which now exists, but with a skill and permanence such that it performs its function satisfactorily today. To the candy industry, true air conditioning means simplified dipping, proper hardening, no more "white" chocolates, in the summer. In the winter, when more-than-natural humidity is required, it means no more brittleness. At all seasons it means greater cleanliness. It may now be said that a candy plant without air conditioning is working under serious difficulties, so widely has its aid been proven.

Paper, during its finishing and subsequent printing, is a prey to the vagaries of weather. When wet, it swells; and when dry, it shrinks. In multi-color printing or in lithography, such actions cause endless grief and much expense. Consequently many paper mills and an increasing number of printers, lithographers and paper converters have adopted air conditioning to overcome these production hazards.

Home-made bread is always allowed to rise, between the kneadings, where it is "nice and warm" and covered by a damp cloth. Who discovered that method, history does not relate. But the modern baker takes a leaf from that book, puts his trough of dough in a room maintained at 90 deg. F. and at 75 per cent relative humidity—about the same temperature and humidity as under the housewife's cloth. The cloth used to dry out and require remoistening from time to time. The baker does not have that difficulty, for automatic controls keep his dough room constantly at the same temperature and humidity, so that today's loaf is just like tomorrow's. If you like his product today, you will like it tomorrow and remain his customer. That is why his has been the fifth big industry which has adopted air conditioning.

There are other industries such as rayon manufacture, photographic film manufacture, artificial leather manufacture, which have standardized on air conditioning as part of the necessary equipment for their plants, but the foregoing examples are typical.

It used to be said amongst air conditioning salesmen that there was no use calling on a manufacturer whose product was made of metal. That rule has proven to be wrong. A great many metal products are polished and then lacquered. If the polishing wheels are set up (abrasive grains glued to the felt wheel) and dried under adverse conditions of humidity and temperature, a decrease of as much as 75 per cent in their life and value may be expected. If the subsequent lacquering is performed under "muggy" conditions, with certain lacquers a "blushing" is sure to occur which will require refinishing when weather is more advantageous.

Not long ago a large manufacturer of electrical equipment discovered that the results of 3 yr. intensive study of high tension currents and their effect on insulating materials was valueless because the research men had neglected to take into account or remedy the natural variations in humidity. An air con-

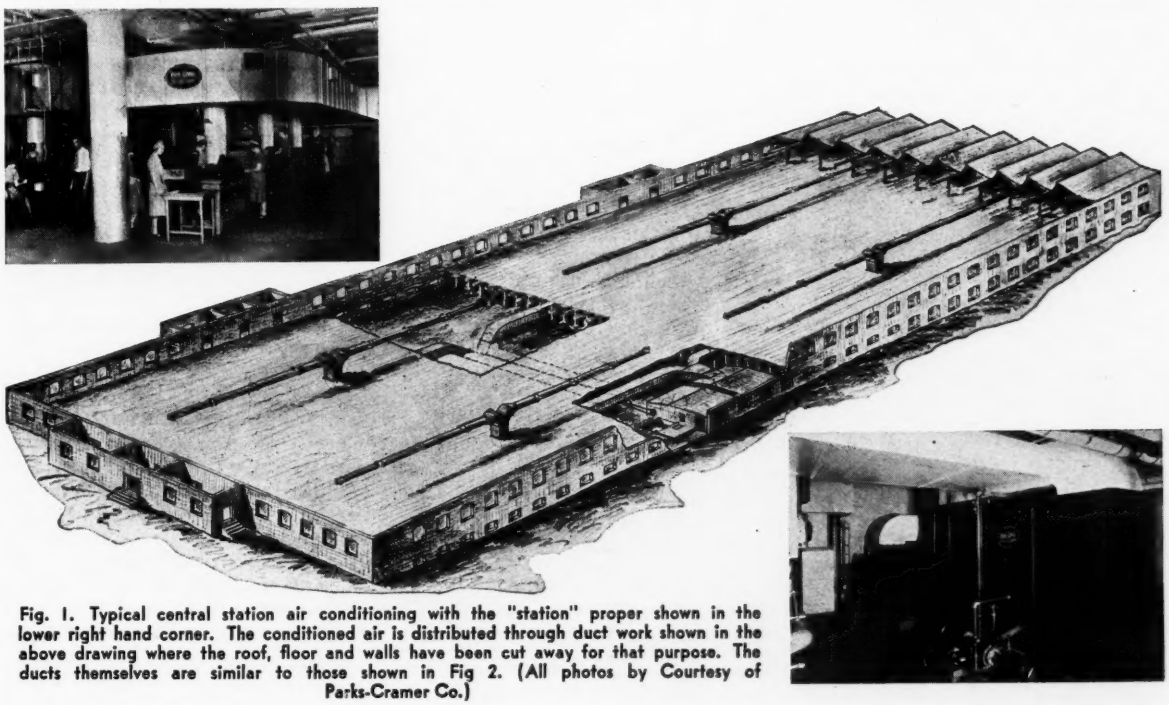


Fig. 1. Typical central station air conditioning with the "station" proper shown in the lower right hand corner. The conditioned air is distributed through duct work shown in the above drawing where the roof, floor and walls have been cut away for that purpose. The ducts themselves are similar to those shown in Fig 2. (All photos by Courtesy of Parks-Cramer Co.)

Fig. 2. In this hosiery mill the air conditioning "station" was suspended from the ceiling

ditioned laboratory with its attendant chart record of conditions being maintained has been a bulwark of defense in many a court case.

Who would ever suspect that synthetic gut tennis racquet strings, a certain form of envelope addressing plate and the colored medium used in theatrical lighting bore any relationship to one another? Yet their basic substances are so alike and react so similarly that the same laws of coagulation and drying apply. Without air conditioning their manufacture must become seasonal.

The old foot-pedal sewing machine is a thing of the past in industry. In its place have come machines which stitch complicated patterns at the rate of 3600 or more stitches per minute. As the needle descends to make the stitch, there is little time for a thread of the cloth being sewn to move out of the way. If that thread is stiff and unyielding, it will probably be cut by the needle. Woe be unto it in the subsequent laundering processes. A humidified atmosphere would have made that thread sufficiently supple and yielding to have moved out of the way or at least to have been only nicked by the needle in passing.

Epsom salts—perish the thought, but one cannot—as well as many other pharmaceutical chemicals are very hygroscopic; they pick up moisture from a damp air and become caked. When they do, it is impossible to handle them properly in a packaging machine. The most satisfactory answer to the problem is a dehumidifying air conditioning system.

Much thought has been given to the storage of perishable food products such as meat, eggs and fruit. Daily one reads advertisements of this or that "Air Conditioned Refrigerator." Regardless of the technical accuracy of this description, as thus applied, one may profitably humidify an egg storage room. During storage, under artificially produced cold conditions, moisture is condensed on the cooling coils (even as in your domestic electric refrigerator); that moisture has come from the air and from the egg. A higher humidity can prevent moisture from being withdrawn from the egg. Its weight will be maintained and also it will taste better because no void will be created therein to become filled with contaminating fumes. If moisture dries out from an apple, its skin withers. Consequently the same remedy is called for in apple storage.

One might continue for some time telling of how this industry or that had solved a perplexing problem by air conditioning. How did the manufacturer discover what was to be the solution?

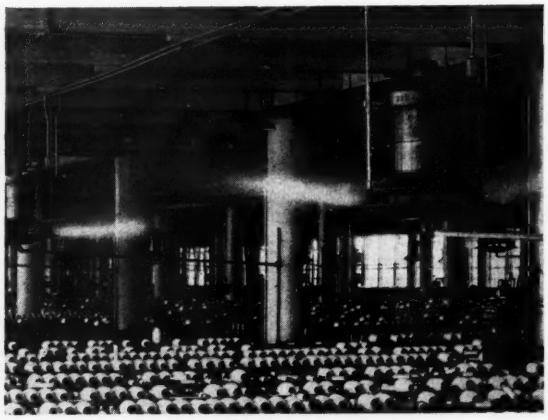


Fig. 4. In this cotton spinning room high duty fan type humidifiers are used

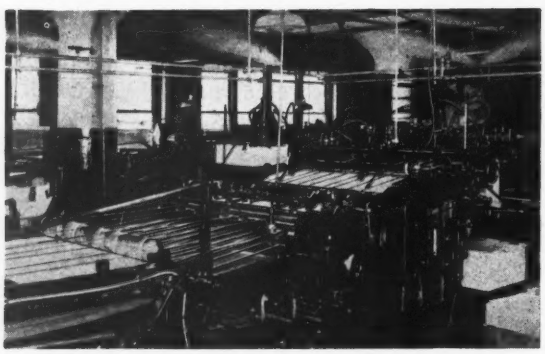


Fig. 3. Direct humidification in a job printing plant by means of atomizer humidifiers

It is axiomatic in the air conditioning art that there is some one condition or a rather narrow range of conditions of temperature and humidity at which a process can be operated best. The whims of nature may produce that condition occasionally for an hour, or even for a day, but seldom for long. Consequently if your factory is not Air Conditioned and if production or quality varies from hour to hour and from day to day, the answer may very conceivably be "in the air."

No mention of the effects of proper air conditioning on health or comfort have been made in this article. Air conditioning is usually installed in industry for more directly productive reasons. But there is no denying the benefits which it will bring from the physical or mental viewpoint. This is an added advantage of air conditioning of sufficient importance to warrant a separate article on this subject.

THE OIL HAZARD

in Power House Equipment

Modern high temperature steam presents fire hazards in connection with electrical equipment that are not present with lower temperatures, as brought out by the author in this article, which describes a number of oil fires and approved fighting methods

By G. M. McNEIL,
Engineer
Associated Factory Mutual Fire Insurance Companies

CASUAL visitors to a modern power house or substation generally see little to cause them to think a serious fire may occur with surprising suddenness. Though usually they have a rather vague feeling that tremendous forces are present which may break their bounds, cause considerable destruction, and possibly injure operators. They see large turbogenerators totally enclosed in steel, but no moving parts. They see transformers and oil circuit breakers, also enclosed in steel. What they do not see is the large quantity of combustible insulation in the generators, the oil in governor and lubricating systems, or the oil in the transformers and circuit breakers; but it is in these that a serious fire is possible, either as a result of mechanical failure or an electrical breakdown.

Steam turbines and their generators must have reliable lubrication; otherwise damage to bearings with more serious damage to shafts, turbine blades, and rotating parts will result. Large-capacity oil systems are therefore provided, so that, unless large leakage occurs, there will still be sufficient oil to lubricate bearings until the rotors come to rest. Ordinarily, pumps driven directly from the turbine shaft or separately by small steam turbines take oil from a tank or reservoir which is located either in the base of the unit or from a separate tank in the basement. Depending upon the size of the turbogenerator, the oil tank may contain as much as 6500 gal., which the pumps deliver to the steam governing valve at 60 to 100 lb. pressure. Then passing through a reducing valve, the oil is piped to turbine and generator bearings at 10 to 30 lb., thence back to the reservoir.

Before steam temperatures were raised above 600 deg. F., the fire hazard of oil used for turbine lubrication and governing systems was not great unless conditions and housekeeping were poor. With many modern turbogenerator units operating on high pressure steam at temperatures of 700, 850, or even 950 deg. F., however, a new hazard

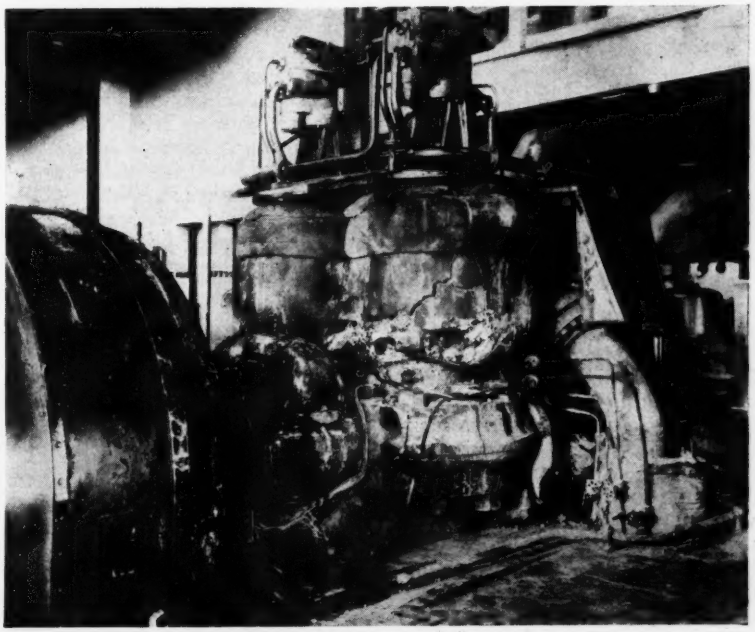


Fig. 1. Fire damaged turbogenerator in public utility station. Oil discharged from a broken 1¼-in. oil pipe to the governor of this 22,500-kw. turbogenerator ignited on hot steam pipes and the resultant fire caused heavy damage to equipment and power house

Fig. 2. Contacts out of adjustment within this double-throw oil type switch touched the bottom of the tank, arced, burned a hole through, and escaping oil ignited. The fire damaged nearby motor control equipment and involved a large generator

is present—namely that oil falling on exposed steam pipes will be instantly ignited. The extent of the fire depends upon the amount of escaping oil, and where this is great, as in the case of a break, burning oil will drop onto all objects and piping and may run into the basement. Such fires are infrequent but are of serious consequence, not only from the damage which results but the possibility of interruption in power output.

Typical Oil Fires in Turbogenerators

Several months ago in a power house of a large cotton mill in North Carolina, the pilot valve stem of the governor on a 3000-kw. turbogenerator dropped into the oil chamber as a lock-nut in which the cotter pin had been left out loosened. This opened a ¾-in. port, and oil under 60 lb. pressure shot high into the air, reaching the plank on steel truss roof. Dropping back, the oil stuck hot steam valve gear at the turbine and immediately burst into flame. An intense fire which followed drove operators from the building, and it was not until 15 min. later when firemen using three large hose streams extinguished the fire at the unit, that they were able to return and shut down the turbine. Most of the oil was consumed, but sufficient remained in the reservoir to keep bearings at the turbine from mechanical damage.

Seventy-seven sprinklers opened and protected the main roof from damage, but in three bays directly above plank, roofing was badly burned and steelwork warped. Sprinklers in this area had been shut off with the idea that they would be turned on in an emergency, but as usually happens in such an arrangement, the valve was not accessible during the early stages of the fire. The outside housing of the turbine, the governor equipment, gages, and auxiliary fittings were melted and badly damaged. Had the sprinklers directly overhead been in service, damage to the building and equipment would have been considerably less. As it was, damage amounted to $10,000 and a considerable interruption to production resulted.

In a plant manufacturing electrical equipment a similar fire occurred, a few months earlier, at a large turbogenerator which was under test. In this instance, the mechanic making an adjustment at the governor allowed the pilot valve stem to drop onto the oil cylinder, and a stream of oil 1 in. in diameter shot forth, which ignited on a 900 deg. F. steam line. About all of the 75 gal. of oil in the reservoir was pumped out, but 16 sprinklers which opened and two large hose streams used by the plant brigade kept the fire from doing any serious damage.

In another instance, at a paper mill, a leak developing at an oil filter in the basement below a turbogenerator, sprayed oil at a bare 14-in. blank steam header and was ignited. Fire damaged piping, valves, and mechanical equipment before being extinguished by hose streams, and because of delay in shutting down the turbine, all the oil was pumped from the reservoir, and bearings were scored and the shaft sprung. Damage amounted to $12,000.

In still another case, at a public utility station, vibration due to faulty adjustment broke a 1¼-in. oil line to the governor of a 22,500-kw. unit, and oil at 90 lb. pressure flowed out and became ignited on hot steam pipes. Flames rose some 45 to 50 ft., went through skylights, and burning oil also flowed into the basement. The power house crew extinguished the fire with two large hose streams, but damage to equipment and to the concrete on steel truss roof amounted to about $50,000. Several similar fires have occurred at utility power houses.

Eliminating the Oil Hazard

Most oil fires at steam turbogenerators occur in the oil governor systems because it is here, with oil under high pressure, that there is greater likelihood of leakage, and if leakage does occur, the oil invariably comes in contact with high-temperature steam piping or equipment. The greatest care may be exercised that all pipes and metal parts at steam temperatures are covered as well as possible, and that baffles or shields are used over hot pipes or parts which may be uncovered, but always the possibility and even probability exists that some high-temperature parts will be exposed, possibly just after repairs have been made.

One excellent method of eliminating this fire hazard is to have the governor system separate from the lubrication system, and as oil is not needed in the governor system for lubricating purposes, a non-flammable oil or some other medium could be used. In some instances this is being done, as in the case of a public utility company in Ohio, where compressed air is used in place of oil in the cylinders of the governors on the larger turbogenerators.

Where lubricating oil is used, tanks or a reservoir should be tightly covered and located reasonably remote from turbines, preferably in a separate well-cut-off room of fire resisting construction. Emergency pumps and their controlling valves should also be safely and accessibly located. Such accessibility at times of fire is important and will make it possible for operators at least to shut the valves of the governor systems and prevent oil in them from being ejected onto a fire in any large quantity. Good judgment would of course be needed in determining whether closing the valves in the lubricating system would result in greater damage than might be caused by fire.

Oil piping should be extra heavy and carefully and substantially supported in as protected locations as possible. All joints should be welded as far as practicable to prevent leakage, although some flexibility is desirable so that vibrations will not be likely to cause breakage. Oil piping to bearings should be run on the opposite side of the turbogenerator from which the steam lines may be located.

Protection Against Fire

Fires of various degrees of size and intensity must be anticipated. For small blazes such as may occur from time to time, suitable types of

fire extinguishers are needed. They should be hung in prominent locations where they are accessible without delay and employees should be instructed in their use.

Where a large quantity of oil is being continuously forced from a leaking joint or broken piping, the fire may be of such proportions as to require greater quantities of extinguishants than are provided by portable extinguishers. Foam from a continuous generator or air foam play pipe might be used if it is possible to put out the fire at the break, but otherwise burning oil would fall upon the foam as fast as it was applied. Water, because of its cooling effect, where used under good pressure and in large amounts, is the most effective means of extinguishing large fires of this type. It can be furnished through large hose streams from 2½-in. hose connections accessible on the main floor and basement of all turbine buildings or from fully equipped yard hydrants immediately outside.

A series of large-scale fire tests at the Factory Mutual Laboratories shows that approved spray nozzles of the non-adjustable type for use on hose lines are even more effective. Working under a pressure of 80 lb., they use less than half the amount of water delivered by a 1⅛-in. smooth bore nozzle, and as they are capable of extinguishing much more rapidly than a solid hose stream, there is less chance of heavy water damage. There should be no hesitation in using the streams. The electrical apparatus in the vicinity will not usually be of the type which will be seriously injured by water, and the operators should be able to make any electrical apparatus "dead" before water can be used.

Switch Gear Fires

From time to time, fires occur in oil switches and circuit breakers. For example, in the power house of a South Carolina cotton mill about a year ago, an oil switch controlling one of the plant's two 15,000 kv-a. generators failed to open the circuit when a short circuit developed and threw burning oil around. Barriers between switching equipment were not complete, and the fire among other things involved the oil switch on the reserve generator. Thus both generators were put out of service, and the loss including that of shutdown amounted to about $60,000.

The amount of oil in any one switch is not great, so arranging for drainage is not usually necessary, although a curb may be provided to check the flow of burning oil in event of a switch blow-up. It is desirable, however, that important controls be separated from one another by substantial barriers. For the most part, oil switches can be satisfactorily located in steel cubicles. At any rate, it is well to have oil switches remote from main power equipment, such as in the basement, on a gallery, or on the other side of a fire wall, and to provide an adequate number of extinguishers to handle the blaze.

Transformer Fires

Transformer fires are usually the result of a break-down in insulation on the transformer windings brought about through gradual deterioration, low oil, moisture or acid in the oil, a strain from a surge, or several other causes. They may also result from grounding of the terminal leads and may happen under a light load or even no load, at any time while the windings are energized. The arcing which follows heats and vaporizes the oil, creating a pressure which may be sufficient to blow off the transformer top or hand-hole cover, or even rupture the transformer casing. When this happens, the oil, some of which has already been heated above its flash point, becomes ignited by the arc, and usually being violently expelled from the transformer shell, burns fiercely and makes a fire difficult to extinguish.

Because of the severe intensity of such a fire, although the probability of occurrence is not great, oil-cooled transformers should preferably be located outdoors well back from main buildings, or if indoors should be in well ventilated and drained non-combustible vaults.

During the past 5 yr. an increasing number of specially designed transformers containing a cooling liquid that will not burn have been used successfully at many industrial plants. Their reliability and characteristics from an electrical standpoint are equivalent to the type containing flammable oil, and being essentially fire-safe, they can safely be located anywhere except in hazardous locations, and do not have to be installed in vaults or otherwise specially safeguarded.

Extinguishing Fires in Immersed-in-Oil Equipment

If a small amount of oil has been expelled or has leaked from its container; or if the fire is confined to the transformer or switch tank, it can generally be put out with one or more portable extinguishers of the vaporizing liquid, carbon dioxide, or dry compound types. Foam will be effective on the fire, but care should be taken not to direct it on "live" equipment, for foam is a conductor of electricity.

For larger fires, whether within buildings, vaults, or outdoors, solid streams of water from large hose lines skillfully used are effective, but water spray backed up by a strong supply of water at good pressure is without doubt the most effective extinguishing agent. Water spray from portable nozzles does an excellent job and is the recommended protection in most instances. To allow for the use of solid streams and water spray, a hydrant system with an ample supply of water from fire pumps, tanks, or public water mains at effective pressure is needed at important power stations and substations.

For important installations where large values are involved and continuity of service is wholly dependent on their operation, physical separation of transformer banks is desirable, or in unavoidable instances where transformers must expose other important transformers or property, a fixed extinguishing system is needed.

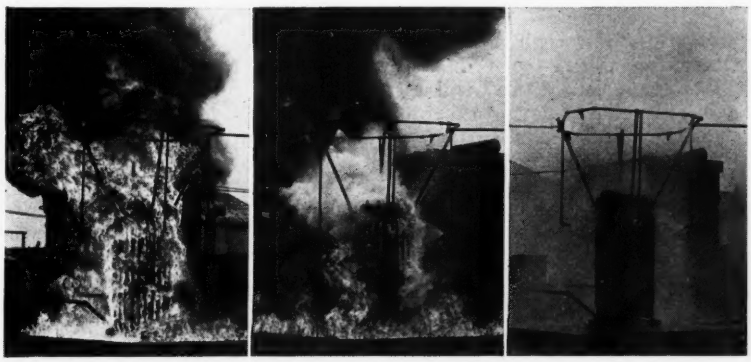


Fig. 3. In this test at the Factory Mutual Laboratories this fixed system of water spray nozzles extinguished the fire in the transil oil of the 150 kv-a. transformer in 4 min.

Part V. You learn a few things about the motor starting controls of an electric driven compressor, while liquid ammonia boiling over into the compressor cylinders pounds some real refrigerating experience into your head

REFRIGERATING ENGINEER

By GEORGE HOLMAN

YOUR THIRD day at the Wholesome Plant gives you a variety of refrigerating experiences. In the first place, you oversleep, and get to the plant a full fifteen minutes late. Frosty is there, but he doesn't say anything about your tardiness. He knows that being late is not in your bones. There isn't any room for it in your bones, for there are too many aches and pains there. In spite of Frosty's ignoring the time of your arrival, you make up your mind that you won't be late again, come sore muscles, aching bones or anything else. Again you find only the cooling room compressor operating.

Heat Squeezer

Frosty says, "The brine temperature is up to 48. By the time we get it down to freezing, you should have the remaining 60 cans fixed and filled and in place. Let's see you start the big heat squeezer."

"What makes you call a compressor a heat squeezer?" you ask.

"Because it squeezes the heat out of the ammonia," Frosty grins.

"That's the heat that comes out through the heads and makes them hot, eh?"

"That's only a part of the heat the compressor squeezes out. Most of the heat is squeezed out through the walls of the tubes in that round vertical heat strainer over there in the corner. Your book calls it a condenser, but it's a heat strainer right on. The heat is pressed through the walls of the tubes and into the circulating water coming down from the cooling tower on the roof."

The suction gage which taps into the cork covered line leading to the ice making compressor shows 75 lb., while the discharge gage shows 160. Under Frosty's direction you open the discharge stop valve—you would have opened that valve without his telling you to!—Oddly enough, he tells you to close the suction stop valve, then leads you into the tank room. "Close that liquid stop valve there ahead of that solenoid stop valve," he tells you, indicating a kind of valve you have not handled before.

"Why?" you obey, but ask anyhow. Both valves are on the liquid ammonia line to the tank coils.

"Well, the brine tank coils had quite a bit of liquid in them the last time the compressor shut down," Frosty explains. "That was two days ago. And leakage past the seat of the solenoid stop valve may have let in more. We are taking no chances. We are closing this stop valve temporarily to make sure that the coils don't fill up with liquid before we get the ammonia pumped out that is already in them. Otherwise when the compressor starts, that solenoid valve will open and let the liquid down to the float regulator. And who knows? Maybe the seat of the float regulator leaks, too."

"Then why do we shut the suction valve at the machine?" you ask.

"Well, ammonia gas now lies on top of whatever ammonia liquid is in the coils." Frosty is very patient. "It is this gas which exerts the so-called vapor pressure which keeps the rest of the ammonia in the liquid state. For aught we know, there may be only a small pocket of this gas in the uppermost part of the coil, while the rest of the coil is entirely filled with liquid. If the compressor started with the suction valve wide open, this gas would be pumped out very quickly. The pressure would fall, and allow the liquid to boil violently. In surging up and down, a lot of the liquid would be drawn into the machine with the gas. Flooding, it is called. The liquid is not compressible, and this machine was not built to handle liquid, there being only $\frac{1}{16}$ in. clearance between the piston and the head of the cylinder. The safety heads would lift, and the resulting pounding of the pistons against the liquid between them and the safety heads may break some part or parts of the machine. I saw a machine once which had the piston rod driven out through the wall of the cylinder.

"So in pumping out an excess or possible excess of liquid in an evaporating coil, first be sure that no more liquid is getting in. And second, be sure that you pump out the gas slowly enough to lower the pressure gradually. This second precaution will prevent the liquid from being carried over into the machine. It is carried out by closing the suction stop valve, then gradually opening it as the compressor pumps out the gas and the level of the evaporating liquid slowly falls in the coils. When this level is low enough, no amount of surging of the liquid will endanger the machine."

You listen respectfully to Frosty's words of wisdom, then go to the switchboard. You look to see that the button is in neutral position, then close the switch. You step back to the button, stare at the word "manual" on one side of it and the word "automatic" on the other, then twist the little latch to automatic position. In spite of the fact that you are set for it, the jar of the main contactor closing on the switchboard makes you jump nervously.

The flywheel pulley turns slowly. You watch it pick up speed. You are about to walk away when something snaps on the switchboard again. You look down. A part of one of the gadgets is slowly moving. As you watch, another contactor closes with a snap. Before the slowly settling control stops moving, five contactors have closed.

Function of the Dashpot

"What's that dooley-whacker for?" you ask Frosty, and point to the control which has now come to rest.

"That's the dashpot and the solenoid that lifts it for delayed starting of the motor," Frosty informs you. "It brings the motor up to speed without endangering the motor windings with an excess of current. It keeps the motor cool by dissipating part of the current through some resisting elements behind the board. These resisting elements are much on the order of the coil of an electric stove. They are not shaped like a stove coil, though; but they serve the same purpose. They allow the motor to act like a transformer while starting, the primary windings being the stator and the rotor acting as the secondary windings to pick up the current and dissipate it through the resisting elements—change it into heat."

The jar of the contactor makes you jump

"But to get back to the dashpot, as soon as the motor picks up a certain amount of speed, that slowly falling weight, checked by the piston in the dashpot, brings a metallic connection there to close one of the sub-circuits and energize a solenoid. This solenoid closes a contactor, which cuts out some of the resisting element behind the board and makes the motor less of a transformer. And so on until the motor is up to speed. Closing of the last contactor prevents the motor from transforming even a small amount of current, except the infinitely small quantity to overcome the slight resistance of the short circuit. By this arrangement the motor is kept from being damaged until it can pick up enough speed to generate the counter electromotive force necessary to protect it from line voltage."

You leave the switchboard and go over to the compressor. You try the bypass and pumpout valves to make sure that they are closed, then slowly—or what you think is slowly—open the suction stop valve two turns.

Correct Oil Pressure

Frosty says, "Better look at the oil pressure gage."

You do. It shows 5 lb. lower than the suction pressure of the ammonia. "Ten to 15 lb. higher than the suction pressure of the ammonia is about right when the suction valve is wide open," Frosty advises. "Right now 5 lb. higher will do. There is an adjusting screw. Screwing it in will raise the oil gage pressure. Backing it out will lower the pressure."

You leave the suction valve where you have it and set the screw as Frosty directs. You set the screw until the gage shows 70 lb., the ammonia pressure in the meantime having fallen to 65.

"Does oil show in the gage glass of that wick feed to the cylinders?" Frosty asks. "That's where the cylinder walls and piston rings are lubricated."

You admit that oil does not show in the gage glass. "Open that little cock on the line to the oil feeder," Frosty adds, and watches while you obey.

You open the suction valve another turn. The compressor grows ominously silent. You are about to open the valve further when Frosty motions to close it instead. You are a trifle slow. Click—click—click—click—clickety-click. You twist the valve as fast as you can. But before you can close it completely there is an awful racket, a thumpety-thump, slam! bang! slam! in the compressor. A fraction of a second after you get the valve closed you are at the switchboard shutting the machine off.

You are scared stiff. You look back to see what has become of Frosty. He is still standing by the machine. "What in thunder happened?" you ask. "Did something in the compressor break?"

"No," Frosty replies. "You opened the valve too wide. The pressure fell too fast and the liquid ammonia boiled over into the cylinders and lifted the safety heads, as I told you it would. The heads may need regrinding on their seats. But other than that, I'm sure no damage was done. Suppose you try again? And don't open the valve so wide until the pressure falls to, say, 50 lb. or less."

You obey, first resetting everything on the machine as it was on your first trial. This time you don't stand at the switchboard until the motor gets up to speed. Instead you walk over to the compressor, adjust the screw regulating the flow of oil and watch the oil rise in the gage glass. You open the suction valve, more slowly this time. Frost begins to form on the compressor manifold.

Frosty doesn't give you any more advice than necessary. But you can see that he is ready to take matters into his own hands.

"How do you suppose the liquid in the coils is faring?" Frosty suddenly asks.

"It's evaporating, I guess," you are not quite sure of your answer.

"Wouldn't it evaporate faster if you started the brine to circulating?" Frosty asks, and grins, his way of telling you what to do.

You had forgotten that the brine had to be circulated. You go to the switchboard, look for a switch with the name "Agitator" under it, close the switch and look for the starting button. Within a minute after you press the starting button of the agitator, the compressor again grows ominously quiet. More frost appears on the manifold. That warning click—click—clickety-click, and you sprint for the

switchboard again. The compressor pounds two or three thumps against the head before it stops. The smell of ammonia, never absent from the machine room since you first entered it, grows noticeably stronger. You listen, and can hear it blowing out past the new gray head of the compressor.

"What went wrong this time?" you ask Frosty.

The Sulphur Taper

Frosty nonchalantly lights a yellow sulphur coated taper. A sharp odor of burning sulphur, worse even than the smell of ammonia, fills the air. A white sweetish-smelling smoke gathers near the taper and drifts upward. Frosty holds the flame of the taper near the gray compressor head, and a horizontal stream of white smoke streams out from beneath the head. "Get a 1¼ in. socket wrench from the tool box," Frosty says. "Here's a bad leak."

You get the wrench. Frosty opens the switch on the board, shuts the discharge stop valve and tightens the nuts on the studs holding the head in place, the blow stops.

"You still have a lot of liquid in the tank coils," Frosty explains. "These coils are in a compartment along one side of the tank. When you first started up and relieved the pressure on it this liquid began to evaporate and cool itself as well as the brine around it. But the agitator wasn't running, so it could get heat to evaporate only from the brine close to it. Starting the agitator brought hot brine from among the cans and threw it against the outside of the pipe coils. The resulting violent boiling caused liquid ammonia to carry over into the machine. See?"

Dimly, you do. You again go through the procedure of starting the compressor. The third time is the charm. You wait until the pressure drops to 25 lb., then go into the tank room and open the liquid stop valve you closed before making your first attempt to start the compressor. You go back and watch the gages. The suction gage rises slowly to 30, 35, 40 lb.

About that time there is a snap of a contactor closing on the switchboard, and a whine and growl as the sharp freezing compressor starts up automatically. You watch the switchboard and note only three contactors cutting out resistance as the motor comes up to speed. Each time one of the contactors closes there is a whine from the motor. "Stop it," Frosty orders. "Those V-belts are too loose. Loosen the anchor bolt nuts and set the motor back until you have tension enough on the belts to keep them from slipping. Wait a minute there! Open the switch. Never work on any machine with a switch to the motor closed.

With the adjusting screws you set the motor back until Frosty approves of the tension on the belts. You bolt the motor down, close the switch and start the motor. "It's starting too fast, and the second cut-out contactor closes too soon after the first one and not soon enough before the third," Frosty still disapproves. "Stop the compressor and set that screw on the dashpot down about two turns. Now set the screw on that second bar up one full turn. Whoa! Open that switch again before you touch that bar. It's alive with 220!"

Full Speed Ahead

The compressors are all going at last. Frosty stands for a few minutes and watches the gages. To your surprise the suction gage of the ice maker is dropping slightly. The discharge gage reads 230 lb. Frosty looks at it for awhile, then at a thermometer on the suction line of the recirculating water pump. He places a portable thermometer in a well set in the liquid line running from the condenser. Then he climbs the ladder to the top of the condenser and reads the temperature of the water coming into the condenser from the cooling tower.

After comparing the three thermometer readings with one another and with the red figures on the discharge gages, Frosty says, "The condenser tubes are pretty dirty; and there's enough air in the system to inflate a political rally. I'll tell you what, Abel. First we'll get those cans fixed. You ought to get that much done today. Then we'll have to clean these condenser tubes and later purge the air. This was supposed to be a modern plant when it was built. But one money-saving piece of equipment was not included. A non-condensible gas purge.

"Here is a practical demonstration of Dalton's law contending that each gas in a mixture of gases exerts its own vapor pressure independent of the presence or absence of other gases," Frosty gets technical, "and that the total pressure of that mixture will be the sum of the absolute pressures of each gas present. The temperature of the liquid ammonia leaving the condenser is 90 deg., and right here at the part of the system where the liquid is warmest. Disregarding superheat, the vapor pressure always corresponds to the temperature of the warmest liquid in the system, never the coldest. By thousands of tests the world over, the pressure exerted by its vapor to keep ammonia liquid at 90 deg. need be only 167 lb. ga. But instead of reading only 167, our gages read 230 lb. Sixty pounds of air.

"Of course, the gages may be incorrect, and the machines constantly delivering superheated gas to the condenser, keep the pressure some higher than the saturation point. But most of that excess pressure is caused by air or other non-condensible gases, such as those sometimes formed by decomposition of lubricating oil. We'll clean the condenser, purge the air, then set that gage that's 5 lb. off. There is a cleaner for the tubes in the tool box. There's no trapdoor over this condenser like there should be. I'll let you worry about how to clean it."

Frosty leaves you to the mercy of 60 more cans and departs for the Aurora. Dog-tired and wearily dragging your feet, you go out of your way past Frosty's home that evening. You meet June Frost, and immediately your tired feeling passes. "Good-evening, Miss—er—June!" you greet her.

June says "Good-evening," rather cooly, and walks on. Dismal and disheartened, you drag your weary bones home. Just to be persistent, you call June on the telephone. In a surprisingly short time she answers your call. "Oh, is it you, Abel?" she says sweetly.

"It sure is! Just thought I'd call up. I wondered what you would be doing tomorrow evening."

"Oh, it might be managed!" June's laughter comes to you. "You may call at about 8 o'clock."

You lie restfully in bed for a long time before going to sleep. Do you still want to be a refrigerating engineer? Heck, yes!

(To be continued)

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

STATIC ELECTRICITY IN MOTION

FOR many years it has been more or less standard practice to hang grounding chains from the metal bodies of automobile trucks and tanks carrying inflammable material. The idea was that such chains provided a path to ground for any static electricity that might tend to collect on the truck as a consequence of its movement over the road. This seemed quite logical but as was shown recently by Robin Beach in an article in Electrical Engineering for May, it is little more than a delusion. Simple in theory, the practice ignored the fact that the modern road is not a conductor, in fact it is a most excellent insulator in most cases. So dragging a chain across it relieves the truck of very little electricity. This problem, while somewhat remote from the functions of the average power plant engineer, is nevertheless of great general interest and in plants where the engineer acts in an advisory capacity on technical matters outside of the power field, the information contained in Mr. Beach's article may prove of value. Incidentally, it is not uncommon for automobiles to generate voltages of 30,000, and even 40,000 volts.

A. W. K.

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KNOWING ALL THE ANSWERS

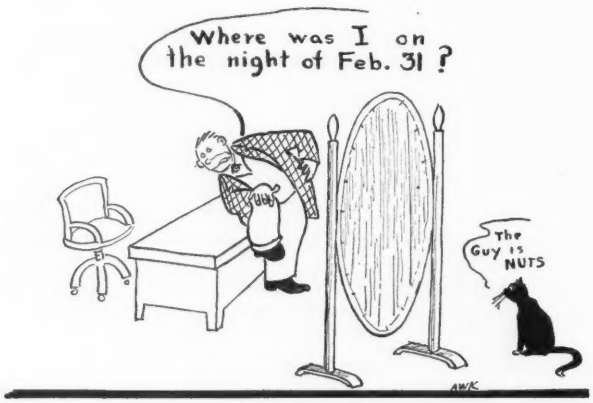
By FRANK V. FAULHABER

Here is an article which consists almost entirely of questions which you can ask yourself. The answers are not given, in fact they cannot be given since you, yourself, are the only one who can answer the questions. They apply to you and to you only. Some of them may be obvious, but if you can answer them all, in the way you should be able to answer them, the chances are you are a pretty good engineer. These are the questions a critic would ask in an analysis of your fitness for your job. It is not a bad idea to put them to yourself before others find it necessary to do so; certainly, it will do you no harm.

NO POWER PLANT engineer can possibly ever know all the answers to questions revolving about his profession, however ambitious and erudite he be. It is nevertheless exceedingly profitable, in the long run, continually to question oneself, determined on getting a better insight into the true nature of ones' work. The really successful engineer is the one who not only asks questions of himself, but is ever keen to answer others' questions. Many times, indeed, an interrogation can be as thought-provoking and productive to the one who answers as it can prove helpful to the one asking the question.

The engineer may be throwing himself, soul and body into his work, forever wondering why other engineers, exerting no greater effort, make greater progress. Is he too close to his work? So close, in fact, that he can hardly find time to devote to the consideration of other power plants, where those in charge also are encountering and solving perplexing, pertinent problems? Does the engineer ever review his entire work as would perhaps a rival or a rank outsider?

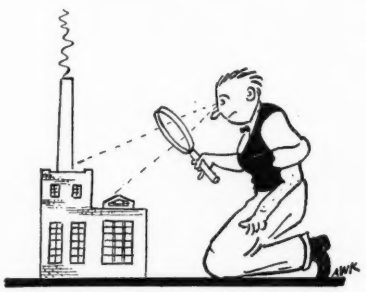
Can it be said that all those now connected with the power plant, down to the lowest sweeper are infected with at least a degree of enthusiasm? What is Mr. Engineer doing to keep the entire staff pepped up? The engineer himself may be imbued up with the proper spirit, at all times, but when some staff member goes down into the doldrums, does the engineer ever attempt to determine the true reason therefore? Perhaps he does not care or consider this a matter within his sphere of action. If so, is the operating staff aware of this and as a consequence does not care either? If such a situation prevails about your power plant, where is it getting you?



Ask yourself these questions

In your own case, what interest and responsibility do you exercise and exhibit whenever a new member must be added? Are you determined on getting the right man, at all costs. If you feel that some of the staff members are not getting the deserved salary, how often do you go to bat for their interests? Have not you, as chief engineer, more logical and tangible knowledge of the real worth of your assistants than the upper management can hope to possess, and shouldn't you drive your arguments home for the benefit of all concerned.

If you are not evoking the proper co-operation from some of your staff, is this because you are not manifesting proper appreciation of their suggestions? How often do you heartily compliment an assistant? If you find that your job seems much more harder than you think it should be it may be due to the fact that



Do you ever look into other plants?

you are making the job too hard for your assistants?

How often do you stage plant meetings, where all of the staff can interchange knowledge and suggestions? What co-operation are you receiving from other departments that in any way touch your responsibilities? Is this something that has been wholly neglected? Doesn't it make for greater all-around plant advance when the engineering staff knows more about what the other departments are doing, and striving to do, and when these other departments, conversely, are more conversant with the engineering staff's operations and doings? Doesn't it, then, make for a more whole-hearted and a more spirited interest, throughout an organization?

Do you deem your present operating machinery and equipment the best, the most appropriate, and fully adequate for the plant's operations and aims? What are you doing to keep the management informed of new machinery and equipment and materials? Has there been any definite discussion of these matters between you and the management, and, if not, why not? If you feel that you must put up with too much antiquated or second-rate equipment, may this be accountable to the fact that you are not displaying enough keen interest in the matter, neglecting also to prod those above, enthusiastically and inspiringly reminding them?

If the management complains because of insufficient results or for lack of proper progress, do you advance facts and figures in support of existing conditions? Can you cite facts why some neighboring power plant can function efficiently, when embarrassing comparisons are presented? If you have to present a negative answer here, is this because you are not being sufficiently inquisitive? Do you confine yourself so closely and so religiously to your own plant that you lose entire sight of other power plants? Do you feel that what happens in other power plants is of no importance and concern to you? If you were to call on more of these plants wouldn't you come away richer in knowledge and with a keener zest for your job, and be better fitted to apply your abilities?

Wouldn't some of these other plants provide you with information that would suggest improvements in your own works, or at least suggest procedure in planning for the future? Whenever you have an unusually preplexing engineering problem, does it occur to you that some neighboring power plant may be able to help solve it for you? Such occasional search for knowledge may lead you into avenues that may suggest a wealth of valuable information.

Ask yourself these questions. They are the ones that your critics would ask and it will be well worth your while to ask them yourself before others find it necessary to do so.

REFRIGERATING PRACTICE

Corrosion Control in Refrigerating Systems

By H. W. Shoaf
Chief Chemist
York Ice Machinery Corp.

IN CERTAIN types of refrigerating systems where uniform temperatures are desired—such as air conditioning units, ice plants, meat packing plants, etc.—it may be desirable to introduce an intermediary cooling agent between the refrigerant evaporator and the objects to be cooled, to maintain more uniform temperature regardless of fluctuation in load conditions or machine operation.

In many systems this intermediary agent is often simply cold water, but in low-temperature applications an agent which is fluid below the freezing point of water is needed. The most inexpensive agent having the proper physical characteristics for this purpose is a strong brine.

The brines generally used in refrigerating systems consist of strong solutions of either calcium or sodium chloride. The preference for one or the other depends largely upon the type of equipment involved, the degree of depression of freezing point desired, relative costs of the salts, and the general effect upon the metals with which they come in contact.

Both calcium and sodium brines have the disadvantages of being corrosive to many metals and especially to steel (iron) and zinc, if not properly handled. This is usually a result of inherent acid or alkali properties of the commercial salts used, absorption of atmospheric gases (i.e. carbon dioxide), or refrigerant leaks (i.e. ammonia). The rate of attack of the brine depends largely upon: (1) degree of alkalinity or acidity, (2) specific gravity, (3) concentration of dissolved oxygen, and (4) temperature.

In general, the minimum amount of corrosion results when proper brine densities are maintained and the solution is neutral or slightly alkaline in character.

pH

Since acidity and alkalinity play a very important part in the effect of brines on metals, it becomes highly desirable to establish a tangible means for evaluating these characteristics. This is readily accomplished by determining the Hydrogen Ion (pH) concentration of the solution. The term pH is derived from the Chemical Theory of Electrolytic Dissociation and is used solely as a means of indicating the concentration of active (ionized) acidity or alkalinity present in a solution. To this term has been assigned numerical values ranging from 0 to 14, as shown in the following scale, in order that a definite unit might replace such descriptive terms as "slightly" or "strongly" acid or alkaline, etc.:

1 2 3 4 5 6 7 8 9 10 11 12 13 14
Completely Acid — Neutral — Completely Alkaline

Any solution with a pH value greater than 7.0 is alkaline, with a pH less than 7.0 is acid. As this scale is based on a logarithmic equation, a variation of one pH unit indicates a tenfold variation in the actual active acidity of alkalinity. For example, a solution with a pH of 10.0 is ten times as alkaline as one having a pH of 9.0—and one hundred times as alkaline as a solution with a pH of 8.0; similarly on the acid side, a pH of 5.0 indicates ten times the acidity shown by a pH of 6.0.

Corrosion

Many authorities hold that zinc coatings are of economic value within a pH range of 6.0 to 10.0. Experience in the refrigeration industry, however, tends toward the more limited range of 7.0 to 8.5 for best results. For bare iron or steel a pH of 7.0 to 8.5 is fairly satisfactory, but a pH of 8.5 to 10.0 is more desirable. These pH ranges may be established and maintained by the treatments outlined in the following paragraphs.

ACID BRINES (pH value below 7.0)

Acidity in brine solutions is generally caused by absorption of atmospheric gases such as carbon dioxide, or by overtreatment with acid correctives. This acidity accelerates corrosion by attacking metal surfaces and protective coatings but can be corrected by the cautious addition, at a point of maximum agitation, of sufficient caustic soda solution, prepared by dissolving the caustic in water in the ratio of not more than one pound caustic soda per gallon of water, to bring about the desired neu-

Brine Testing Set

trality or slight alkalinity. The rate at which this solution may be added should ordinarily not exceed 1 gal. per hr. per 1,000 cu. ft. of brine to be treated. This is suggested in order to avoid overtreatment, and possible detrimental effects, especially upon zinc coated surfaces, which might arise from concentration or stratification areas due to lack of thorough mixing.

This rate of treatment should prove satisfactory provided a test is made at frequent intervals by adding several drops of a phenolphthalein solution to a small quantity (i.e. 10 c.c.) of the brine being treated. If the pH value is below 8.3 no change in color will take place, but if it is above 8.3 a pink or red color will develop. The treatment should not exceed the point at which the first faint pink tint appears, as the pH value at this point will be at least 8.3. If the treatment is stopped promptly, the pH of the brine, after thorough mixing, should not exceed 8.5. At this point the exact pH value should be established by the use of a pH testing set, such as the one described at the end of this article. After allowing the brine to circulate for several additional hours to be sure that thorough equalization has taken place, this determination should be repeated.

Alkaline Brines

Excessively alkaline brines may produce localized attack on iron and steel, and will definitely remove zinc coatings. If alkalinity results from the making up of a new calcium chloride brine, the addition of this salt to strengthen weak calcium brines already in existence, or overtreatment with alkaline correctives, it may be reduced to the proper neutral or slightly alkaline condition by the cautious addition, at a point of maximum agitation, of sufficient hydrochloric acid diluted one part of acid to three parts of water. The same care and rate of addition must be observed in this treatment as was previously outlined for the use of caustic soda in the correction of acidity. In using phenolphthalein indicator as a check upon the progress of treatment, the deep pink or red color produced will gradually fade with increasing acid addition until the test solution will become colorless at pH 8.3. It is desirable and necessary that the treatment be stopped just before this point is reached, which is denoted by only a faint pink coloration. Here again checks should be made by use of a pH testing set.

The foregoing comments on alkalinity did not include contamination of a brine with ammonia for the reason that this element is not only capable of increasing alkalinity, but also combined with the sodium or calcium chloride present, and also with hydrochloric acid if used for neutralization, to form corrosive ammonium salts. Neutralization of a highly contaminated brine of this nature with hydrochloric acid alone is not usually advisable. Treatment with sodium dichromate or chromic acid reduces this tendency and serves to retard corrosion.

Sodium Dichromate Treatment

Ammonia Contaminated Brines:

The full quantity of dichromate as recommended by the A.S.R.E. Corrosion Committee should always be used with a brine of this type, regardless of existing or resultant Hydrogen Ion Concentration. Subsequent pH corrections are made by the use of acid or alkali as previously mentioned. The most reliable method of checking the effectiveness of this type of treatment is to suspend bright steel and zinc coated steel panels in the solution and observe for abnormal corrosion.

It frequently happens from an economic standpoint that treatment of an ammonia contaminated brine is not advisable, and for this reason it is best to secure the advice of a competent chemist before any type of treatment is attempted.

Sodium Dichromate Brine Treatment

Ammonia Free Brines:

With few exceptions, the sodium dichromatic treatment, as recommended by the A.S.R.E. Corrosion Committee, offers a reliable and effective means of economically treating both sodium and calcium brines for the purpose of minimizing corrosion. For brines with existing pH values of 8.5 or below, the initial treatment consists of dissolving the bright orange granular sodium dichromate in warm water in a suitable metal or wood container of convenient size, neutralizing with caustic soda solution, and then slowly pumping or pouring the neutralized sodium dichromate into the brine.

The recommended quantities for brines not previously treated with dichromate are as follows:

Calcium Brine—100 lb. Sodium Dichromate per 1,000 cu. ft.

Sodium Brine—200 lb. Sodium Dichromate per 1,000 cu. ft.

Approximately 35 lb. of 76 per cent commercial flake caustic soda will be required to neutralize 100 lb. of Sodium Dichromate.

If this method is properly applied to brines already within the desired pH range of 7.0 to 8.5, no further chemical manipulation will be required; but should they be on the acid side (below pH 7.0), sufficient additional caustic must be added to the brine tank proper to raise the alkalinity to the desired pH.

With excessively alkaline brines, the previously dissolved dichromate should not be neutralized with caustic soda, as suggested above, but rather should be added to the brine in its original acid form to serve the purpose of reducing the alkalinity. If the brine was sufficiently alkaline to begin with, no caustic will be required, but if this is not the case, then sufficient caustic should be added to the brine system to reach the proper pH range, as previously described.

Should the brines still be slightly too alkaline after treatment, due to initial alkalinity or to inadvertently adding too much caustic soda, this condition usually can be corrected by adding a slight additional amount of previously dissolved sodium dichromate, not to exceed 25 lb. per 1,000 cu. ft. over and above that recommended. If this amount is not sufficient to reduce the alkalinity to pH 8.5, then the hydrochloric acid treatment should be used. For best results with the dichromate treatment, the pH value of the brine should always be carefully maintained in the proper pH range as is customary with untreated brines.

To maintain the approximate desired concentration of sodium chromate at all times, it will be necessary to include sodium dichromate each time sodium or calcium chloride is used to strengthen the brine. The approximate amount should be ½ lb. of sodium dichromate per 100 lb. of calcium chloride, and 1¼ lb. of dichromate per 100 lb. of sodium chloride.

Titration

It will be noted from the preceding comments that predetermined definite quantities for treatment have not been set forth due to the fact that pH values cannot be used as a basis upon which to calculate beforehand the exact amount of corrective chemical needed. The only means of accurately predetermining the quantity required is by titration. Even though the titration method if preferable from the standpoint of ease of application of treatment, it does not offer a practical means of determining pH values. The pH testing set on the other hand can be successfully applied to both phases and should always be used in conjunction with maintenance and control of refrigerating brines.

Density

Another factor which plays a part in the corrosiveness of brines is oxygen concentration. Brines of low density absorb excessive amounts of this element and for this reason the following densities are recommended:

Sodium Chloride—1.15 to 1.175 at 60 deg. F.

Calcium Chloride—1.20 to 1.24 at 60 deg. F.

Any increase in density of sodium brines above 1.175 will be undesirable due to rise in freezing point temperatures.

If calcium brine densities in excess of 1.24 are required (as in the case of very low temperature work) more powerful pumps and agitators must be selected to circulate the brine.

pH (Hydrogen Ion) Control

pH control is by no means limited to brines, but finds widespread application in conjunction with water treatment for ice making purposes, as well as the proper maintenance of such equipment as cooling towers, spray ponds and evaporative condensers. Water may naturally contain, or may absorb from the air, elements conducive to excessive corrosion unless corrective chemicals are

added and the solution held within the proper pH range.

For years the York Ice Machinery Corporation has recognized the value of pH control, and in an endeavor to assist the refrigeration industry with its corrosion problems has developed a compact and practical testing set for this purpose, called the Improved York Brine Testing Set. It contains standard color comparator ampoules, in 0.5 pH increments, covering the range from 5.0 to 10.0 inclusive, along with a supply of suitable indicator. In addition a thermometer, hydrometer and a quantity of phenolphthalein solution is supplied. The hydrometer may be used for both sodium and calcium brines or any other solution with densities between 1.050 and 1.250.

FOR THE PLANT ELECTRICIAN

Connection and Installation of Ground Detectors

By Eugene George Key

IN THE USUAL power installation, a single ground does not cause any serious damage. If a second ground occurs, however, the result is a short circuit. Often, the first ground does not make itself known until the second occurs. Fires or other damage to equipment, building, or wiring sometimes result. Even in a normally grounded system, a partial ground may not give very much indication when it first appears, but, if not detected soon afterward, may cause severe damage.

In order to avoid these difficulties, electrical equipment and instrument manufacturers have designed apparatus of various kinds which give an immediate and positive indication as soon as an accidental ground occurs. Much of this equipment is so expensive, however, that engineers and electricians prefer to plod along and take chances instead of making the large expenditures necessary for that equipment. Ground detector systems can be designed and installed in a few minutes and at small cost, yet which give adequate indications of even the slightest ground faults as soon as they occur.

The principle of a good ground detector is the deliberate grounding of all line wires in a power or lighting system, using a high resistance indicator of some kind, sometimes a meter which gives the exact voltage between a line and a ground. Usually, knowing the exact voltage is not necessary, and lamps will give sufficient indication for all practical purposes.

An accidental ground on an unbalanced neutral system should be detected immediately and cleared. The dangerous conditions caused by an accidental ground on this system were explained in two recent articles in POWER PLANT ENGINEERING[1] and should be consulted again. A ground detector for this system is shown in Fig. 1.

The voltage from either A or B phase to neutral is 115 v. if the voltage across phase wires is 230. The voltage from C phase to neutral is then 199 v. Figure 1 shows single lamps connected from A and B to ground. As the voltage from C to neutral is 1.732 times that from A or B to neutral, either one 220-v. lamp or two 115-v. lamps are needed. If an accidental ground occurs on any of the phases, the lamp or lamps connected to that phase will either go dim or go out, depending on the severity of the fault. Since the factory lights are connected from A and B to neutral, all lights connected to the faulted phase will give the same indication except that in a partial ground—one that is not solid from phase to ground—may not give sufficient indication.

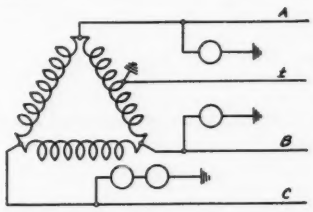
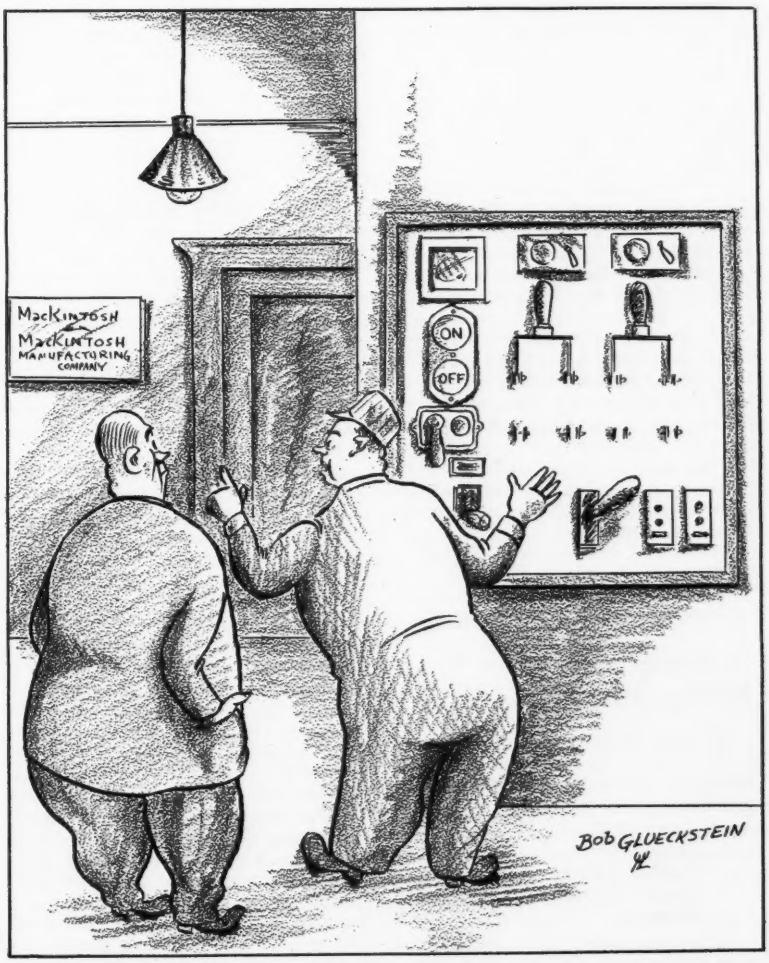


Fig. 1

The lamps used in any of the detectors described in this article should be of very low wattage—7.5 watts or lower if those sizes are available. A variable resistor in series with the lamps can be used to regulate the brilliancy. When the lamps are connected as shown in Fig. 1 with the variable resistor (not shown),

(Continued on Page 98)



"It's just to turn on this light—the management here tries every means to save on electricity!"

[1]April issue, page 90; May issue, page 90.

Questions And Answers

116

Copper Switches Corrode

What steps can be taken to prevent or reduce the corrosion effects of sulphuric acid fumes on our electric knife switches and electric circuit breakers?

Buffalo, N. Y. B. H. W.

117

Use of Steam in Atomizing Burners

In tests recently conducted with industrial oil burners of the steam atomizing, pressure temperature atomizing and mechanical atomizing types, it was found that the efficencies in the latter two classes were improved by the admission of some steam as with the steam atomizing burner.

We were under the impression that the injection of steam with the fuel would reduce the efficiency by the amount of heat absorbed by the water.

The reason offered for the unexpected increase in economy was: besides increasing the gas turbulence in the furnace with its resulting earlier ignition, etc., the steam dissociated into its elements, hydrogen and oxygen, at temperatures of 2200 deg. F. and up, thus adding to, rather than subtracting available heat from the total input.

Can someone having had experience advise us concerning this problem? If it's true we are going to throw out the oil and just burn steam.

Edward H. Goebel

Grand Rapids, Mich.

118

Locating Leaks in Refrigerating Systems

What is the usual procedure involved in finding leaks in refrigerating systems using the following different refrigerants?

Freon (F-12)
Carbon Dioxide
Sulphur Dioxide
Methyl Chloride
Ammonia

Any information that readers can give on this subject will be much appreciated. Oscar Altman

New York, N. Y.

A. 86

Another Answer to the SOS From the Philippines

Referring to the question asked by F. T. Lauriat in the January issue, the writer, in a particular instance in a New Jersey Co. some 15 yr. ago, solved the problem by inserting a plunger relay in the neutral current transformer secondary. This, in turn, whenever a ground fault occurred, started a synchronous motor driven timer which after 5 sec. caused an oil circuit breaker to close, short circuiting the resistor which had a 10 sec. rating and at the same time sounded an alarm. The arrangement always operated satisfactorily.

C. O. Von Dannenberg

Brooklyn, N. Y.

A. 96

Trouble With Manhole Plates

Your February 1941 issue of Power Plant Engineering contains a boiler question by D. H. W. concerning leaky manhole cover plate gaskets in h.r.t. boilers. Leaky gaskets, both handhole and manhole, have been the bane of every operating engineer from time immemorial. Why? Because the man in the field simply puts up with it and accepts it as "one of those things." Few men have shown enough interest in the problem to tackle it and have succeeded in solving it. We can dismiss handhole plate leaks because with the advent of the key caps this bothersome problem has been practically eliminated. What about the manhole gasket leaks—here is another story altogether.

Since we are dealing with an h.r.t. boiler at the present moment, it might be well to see what the "code" requires as to manhole openings. We will assume a pressed in manhole opening.

The code requires the manufacturer to meet certain minimum requirements concerning the manhole opening in a boiler, i.e., a minimum width of 11/16 in. bearing surface for a gasket is required on a manhole opening. An h.r.t. boiler of the size mentioned (72 by 14 in.) would have a minimum head thickness of ½ in., therefore to comply with the code requirements for width of bearing surface for a gasket a band or ring of steel is usually shrunk on the flanged-in section of the opening. This band is generally ½ by 1½ in. strap iron and is usually held in place by dowel pins or welded in. The surface of the opening is then machined to insure a perfect fit with the gasket and the plate. The reason for the code requiring this minimum bearing surface must be obvious. Now then, sometimes these bands become loose in service or the surface is cut or grooved, in either case the band must be made tight and the surface trued up again before replacing the gasket and the plate.

There are several types of cover plates in use, but the most extensively used plate is of a pressed steel type with pressed steel arch bars or dogs. The advantage of this type of plate is, that it is lighter than any other form and it is cheaper to manufacture. The usual plate is ½ in. thick with two 1¼ in. bolts, the bolts being either fixed or movable depending on the design. The plate may be convex or have several pressed "waves" in it. Due to the method of fabrication—loose dies—sloppy fit and an "I don't care attitude" on the part of the pressmen, these plates have a peculiar disadvantage all their own; this disadvantage is a lack of sufficient provision for holding in the gasket at its outer edge and hence the gasket is liable to be blown out or dislodged enough to produce leakage under high pressures. It will also be noted that the plate as designed (½ in. thick) is safe as far as stress conditions are concerned, but how about the practical conditions that will be encountered in its use? Again, the question may arise as to the proper gasket to be used with a certain plate.

Let's see what actually takes place when a manhole plate is placed in service: we will assume that the head gasket surface is true—that the plate surface is true and that a standard type of gasket is used. When D. H. W. first tightened up his plate after installing a new gasket, the joint was tight for several weeks and then it began to leak and on further tightening the leakage became worse.

The plate upon the first tightening was subjected to a light strain—enough to slightly compress the gasket to prevent leakage. As pressure was raised on the boiler, the gasket was further depressed and the plate was deflected a little (check this with a dial micrometer) with the compression of the gasket, coupled with a loose fitting plate in the opening the plate had a tendency to move, and so with the constant raising and lowering of the steam pressure and the subsequent heating and cooling of the boiler the movement of the plate was sufficient to cause the breaking of the bond that had been originally established between the plate and the gasket. Leakage then developed and the normal reaction to leakage is to tighten up the object. D. H. W. did this and to his chagrin the leakage became worse. Why?

In the first place the gasket had been compressed to its limit and was therefore useless as a gasket, secondly upon tightening up the plate the second time the plate was deflected to such an extent that the normal parallel planes that exist between plate and head were destroyed beyond repair. Thus the leakage was merely aggravated instead of helped.

To remedy the situation the manhole plate must meet several practical requirements which are: first, the plate must be sufficiently strong, thick to resist the deflection moment, in other words it must not bend under the strain that it will be subjected to. Second, the plate must be so designed to provide a maximum retaining edge for the gasket—this is important—because this edge must present a square surface at right angles to the gasket for a distance of at least ¼ in. (this is required since the code prohibits the use of a gasket having a thickness greater than ¼ in. when compressed) to prevent the gasket from crawling up between the plate and the opening. The plate must also fit the opening to a very close tolerance—this is essential in order to keep the gasket from squeezing out between the plate and the opening. Never use an ill fitting plate—one that practically floats around in the opening—this in itself is the chief cause of leaky manhole cover plates. Use a good heavy plate, well designed and one that snugly fits the opening and your leakage troubles will be over.

Williamsport, Pa. K. A. PIPPART

If D. H. W. will make a boiler manhole gasket from 5/8 in. extra heavy lead pipe, fit the lead pipe snugly around the manhead, join the pipe together with a step cut joint, the joint soldered, using tallow for a flux. Be sure to scrape or clean bright before trying to solder.

Hammer the pipe down, using a small board on the lead so as to make a flat top. The lead pipe being hollow and soft will take up all unevenness in both the manhead and boiler and will make a strong lasting job that can be used over and over by simply applying two rings of ½ in. asbestos wicking graphited after each using.

Be sure to draw up well and follow up as steam rises on first application. It may be necessary to hammer lightly around manhole while cold water is going in till seated.

The writer has used this gasket on some bad manheads and it hasn't failed yet.

Indianapolis, Ind. J. H. LAMAR

A. 99

Oil Finish on Switchboards

IN ANSWER to C. Stith's question in the February issue, we have used with very satisfactory results a solution of 60 per cent carbon tetrachloride and 40 per cent brake magnet oil obtained from the Otis Elevator Co. The solution can be applied with a spray gun or an insect spray. The sprayed slate will have a very unsatisfactory appearance for the first three or four days after the first application, but the desired finish after that time will make its appearance. The panel can be given several coats, and to get the best results it should be carefully rubbed down with a soft cloth.

Galveston, Texas J. M. HARLEY

Answering Mr. Stith's oil finished switchboard problem in your February 1941 issue.

I have had Mr. Stith's experience in trying to keep switchboards looking nice and shiny, and, although I do not know what preparation the manufacturers use, I can advise him what I am doing to improve the looks of the switchboards around my palace of energy.

First, let me say, that there are 2 switchboards, of which 1 is composed of cement and asbestos pressed together and enameled, the other is just a plain black slate switchboard.

A good grade of nationally advertised polishing wax applied according to directions on can, plus lots of elbow grease the first time, is what does the job. After that, a light polishing every few days will maintain the lustre, unless the boys around the plant have the habit of leaning against the boards with their dirty hands. When the lustre appears to be growing dull, another coat of polish will bring it back.

PAUL F. DICKENS, SR.
Quanah, Texas

A. 100

At Last, an Answer to the Motor Repair Shop Problem

IN REPLY to your question in the April issue of the Practical Engineer & Electrician as to what was wrong with the inquiry as to how to establish a motor repair shop, I'd say that the question was well put, timely and relevant, and that there was nothing wrong with it. Consider, however, just how few of your readers ever have occasion to plan and establish such a shop. If, however, you had asked how we would like to plan a shop, I am sure that fine answers would not have been lacking. The great majority of engineers are employed in plants where the request for such small items as pliers and tape is received with scowls and emphatic denials. As to obtaining a whole shop, well, I leave the volcanic denial to your imagination.

To establish a motor repair shop you would need, first:

A room of ample size, well lighted, centrally located with respect to the motor distribution of the plant in question. So that motors could be readily transported to and from the shop, and so that the trouble shooters could get to defective motors with least delay. And second:

The room should be serviced with d.c. and a.c. circuits of correct voltage and capacity, so as to facilitate the test of any motor likely to be brought in for repair. In connection with the above, a large generator and water rheostats should be installed, so that motors could be used to drive the generator, as a dynamometer, and thus fully tested under load. For the third item we,

Should have a complete set of instruments, meters, etc. These would enable us to obtain all information about the patient. Naturally the shop should be equipped with a lathe for the reconditioning of slip rings and commutators and other such work. Also a complete set of hand tools, pliers, screw drivers, hard and soft hammers, spare brushes, wire, tape, varnish, cleaning liquids, drying oven, commutator stones, compressed air fuse test board, etc. Also a complete file of manufacturers' data on the various motors in the plant.

Of course no shop would be complete without a compact, portable motor testing kit, so that preliminary surveys could be made with motors on the job.

The layout of the whole shop would have to be based on the motor equipment of the plant as to size of motors, number of motors, make and type of motors, the application of the motors, and the per cent availability demand of the motors.

Last, and certainly not least, the shop should be in charge of a competent, inventive and ingenious mechanic, who should be well paid for his responsibility.

Wingdale, N. Y. SAM WILLIAMS

It Is Dangerous

IN QUESTION 101 in the March issue a generator connection is shown with the query. "Is it dangerous?"

I would say that it is. As long as everything goes along well, it will work, but if anything should happen to that series field and it should have to be disconnected and worked on, the danger to the workman would be evident.

No piece of equipment should ever be connected without some provisions to disconnect it from the live circuits, even though the voltages involved are low. It is dangerous also to the equipment. If any turns in the field should become grounded or damaged, it may cause terrific damage to the buswork to which it is connected, as there is no way of disconnecting it from the circuit until the actual connections are torn apart in some way.

Chicago, Ill. EUGENE GEORGE KEY

In my opinion the generator mentioned in question 101 can be operated without danger to operator or switchboard equipment. In making this statement, however, it is assumed the machine is used only for booster purposes where the produced current has very low amperage. In any case, I would ground the housing in order to eliminate every possibility of danger when a breakdown of the insulation in the armature or field occurs.

New York, N. Y. CARL EGERTER

In regard to the letter of H. Gould (101), in the March issue, the fact that one side of the motor is always hot,

and therefore dangerous to the operator or mechanic, would be sufficient reason to replace the present single pole switch with a double pole switch of proper capacity.

We would, however, prefer the installation of a combined switch and automatic circuit breaker, and eliminate the breaker shown in the drawing.

Incidentally, it would be interesting to know what a series motor of this size is used for, outside of traction purposes. The drawing shows a series motor, so we assume that that is the case.

Wingdale, N. Y. SAM WILLIAMS

A. 104

Determining Power Costs

WITH REFERENCE to Mr. F. C. D.'s request for mathematically determining the Rankine Cycle Efficiency of his condensing turbine, may I present my thoughts and answers to his problem in the March issue?

Given: A certain 1500-kw. turbine has a guaranteed water rate of 13 lb. per kw-hr. when operating under the following conditions:

Steam press. at throttle, 250 lb. gage.
Superheat, 150 deg. F.
Vacuum, 27.5 in.

Question:

1. Can the Rankine Cycle Efficiency of this machine be determined from the Mollier Diagram? Can this be done without making any assumption?

Answer.

1. No, the Rankine Cycle Efficiency of the given machine cannot be determined purely from the Mollier Diagram, but may be determined from values obtained from the Mollier Chart.

The efficiency of the Rankine Engine cycle may be obtained from the expression:

$$\text{Combined Eff.} = \frac{3413 \text{ B.t.u. per kw.}}{Wk\ (ha - hc)}$$

where

Wk = weight of steam used by actual engine in lb. per kw-hr.

ha = specific heat content of the vapor at the throttle.

hc = specific heat content of the condensate at actual exhaust pressure.

The value of ha is 1292 B.t.u. per lb. from the Mollier diagram or Keenan's Steam Tables.

The value of hc is 76.6 B.t.u. per lb. for 27.5 in. Hg. vacuum (referred to 30 in. Barometer (Mercury at 58.4 deg. F.).

The value for Wk according to the guarantee is 13 lb. per kw-hr.

Substituting the above values in the eff. equation,

$$\text{Combined turbogenerator eff.} = \frac{3413}{13(1292 - 76.6)} = 21.6 \text{ per cent.}$$

The only assumption we have made in determination of the above efficiency is using the guaranteed water rate of 13.

Question:

2. Can the water rate, when operating under the primary steam conditions as given above, with the same superheat, be determined, when operating at 26 in. vacuum?

Answer:

2. Yes. The steam rates for the two exhaust conditions are approximately proportional to their theoretical steam rates, given by the expression $\frac{3413}{ha - hb}$, where

hb = specific heat content of the vapor at exhaust pressure.

Hence,

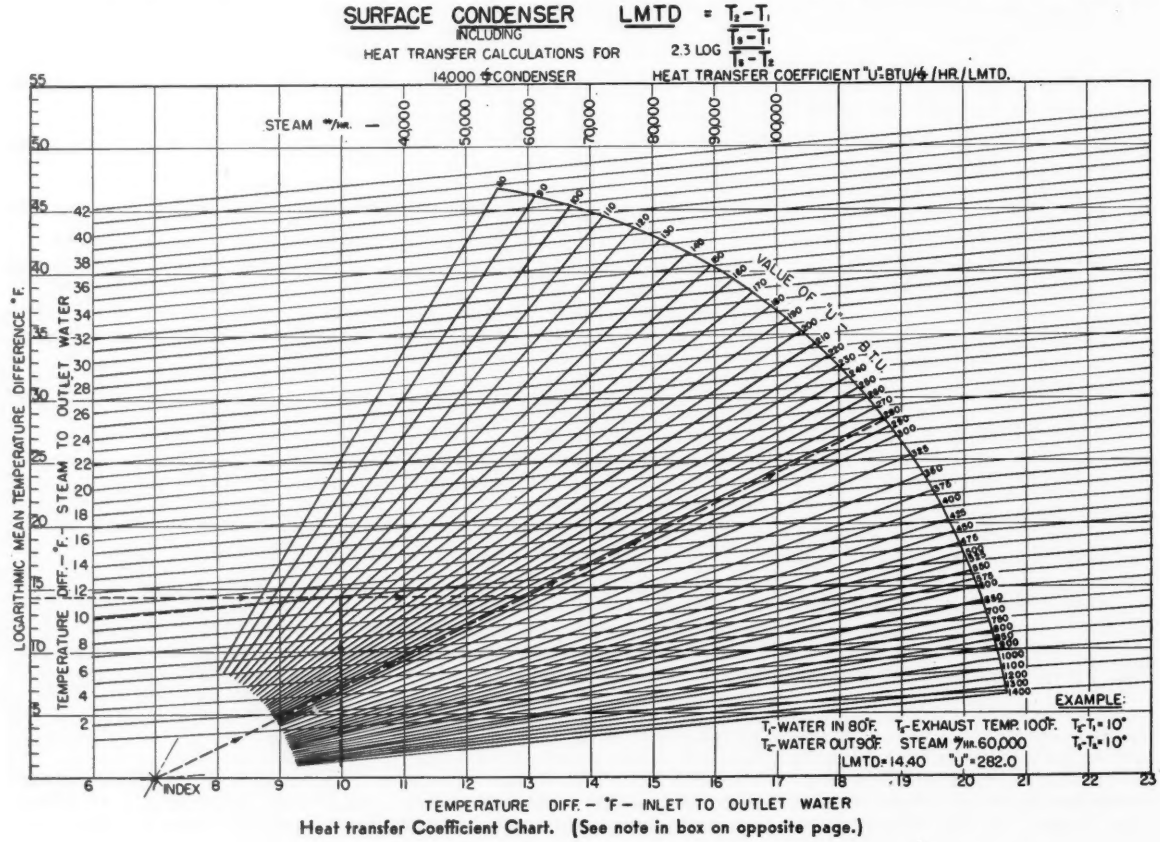
$$\frac{\text{Water rate at 26 in. vacuum}}{13} = \frac{\frac{3413}{ha - hb}}{\frac{3413}{ha - hb_1}}$$

$$\frac{Wk}{13} = \frac{ha - hb_1}{ha - hb}$$

$$\text{Substituting} \quad Wk = \frac{13(1292 - 914)}{1292 - 938}$$

$$\text{Wk at 26 in. vacuum} = \frac{13 \times 378}{354} = 13.88 \text{ or } 13.9 \text{ lb. per kw-hr.}$$

The values for hb and hb_1 were obtained from the Mollier Diagram by finding the intersection where the exhaust


SURFACE CONDENSER INCLUDING HEAT TRANSFER CALCULATIONS FOR 14,000 ☐ CONDENSER
LMTD = (T2 - T1) / 2.3 LOG (T3 - T1) / (T3 - T2)
HEAT TRANSFER COEFFICIENT "U" BTU/☐/HR/LMTD.
STEAM #/HR. — 40,000 50,000 60,000 70,000 80,000 90,000 100,000
VALUE OF "U"
LOGARITHMIC MEAN TEMPERATURE DIFFERENCE °F.
STEAM TO OUTLET WATER TEMPERATURE DIFF. — °F.
INDEX
EXAMPLE:
T1-WATER IN 80°F. T2-EXHAUST TEMP. 100°F. T2-T1=10°
T3-WATER OUT 90°F. STEAM #/HR. 60,000 T3-T4=10°
LMTD=14.40 "U"=282.0
TEMPERATURE DIFF. — °F — INLET TO OUTLET WATER

Heat transfer Coefficient Chart. (See note in box on opposite page.)

pressure lines for 4 in. and 2.5 in. Hg. cross the same entropy value found for the initial conditions.

I hope that the above information will be of help to Mr. F. C. D. in determining his power costs.

EDWIN Z. GABRIEL.

Montclair, N. J.

The Rankine Cycle Efficiency (Thermal Efficiency) is applicable to all heat engines of whatever make and is given by the equation:

$$Er = \frac{Hi - Hn}{Hi - qn}$$

where Hi = initial heat content of the steam,
Hn = final heat content after adiabatic expansion to final condition n,
qn = heat of the liquid corresponding to the exhaust temperature.

Inspection of the Mollier diagram shows total heats plotted as ordinates vs. entropy as abscissa. It cannot therefore be used *alone* to solve the problem since qn must be separately determined as follows:

From the Mollier Diagram reproduced from Prof. J. H. Keenan's latest steam tables we obtain:

Hi corresponding to 265 lb. per sq. in. abs. pressure and 556.11 deg. F. total steam temperature = 1291 B.t.u. per lb.

Hn corresponding to 27.5 in. Hg. vacuum or 1.23 lb. per sq. in. abs. pressure = 915.0 B.t.u. per lb.

qn (corresponding to 27.5 in. Hg. vacuum (from Keenan's steam tables) = 75.3 B.t.u. per lb.

$$\text{whence } Er = \frac{1291.0 - 915.0}{1291.0 - 75.3} = 31.0 \text{ per cent.}$$

where extreme accuracy is desired or when the given conditions lie beyond the range of the Mollier charts the Rankin Cycle Efficiency may be determined by steam tables alone, as follows, from Keenan's Tables.

Hi = 1291.8 and qn = 75.3 as above (in B.t.u. per lb.)

N_1 = total entropy at 265 lb. per sq. in. abs. pressure and 556.11 deg. F. total steam temp. = 1.6184.

r_2 = latent heat of vaporization at 27.5 in. Hg. vacuum = 1032.2 B.t.u. per lb.

n_2 = entropy of the vapor at 27.5 in. Hg. vacuum = 1.767.

θ_2 = entropy of the liquid at 27.5 in. Hg vacuum = .1426.

Then x_2 = the final quality of the steam

$$= \frac{N_1 - \theta_2}{n_2} = \frac{1.6184 - .1426}{1.767} = .83$$

So that

$$Er = \frac{1291.8 - (.83 \times 1032.2 + 75.3)}{1291.8 - 75.3} = 30.2 \text{ per cent}$$

The Rankine Cycle Ratio, not to be confused with the Rankine Cycle Efficiency, is given by the equation:

$$E = \frac{3413}{W\,(Hi - Hn)}$$

where W = pounds of steam per kilowatt-hour and Hi-Hn are as above. This may be readily determined from the Mollier diagram and for the given problem is

$$E = \frac{3413}{13(1291 - 915)} = 70.0 \text{ per cent.}$$

Determining water rates under conditions other than those determined by test or guaranteed by the turbine manufacturer can most accurately be done by use of correction curves for the particular turbine installation, since every machine's performance varies through a rather wide range for different operating conditions. For purposes of comparison of water rates when operating with the given primary steam conditions and 26 in. Hg. vacuum vs. 27.5 in. Hg. vacuum, tests have shown an *increase* of about 5 per cent in steam consumption for each inch *decrease* between 27 and 25 in. vacuum. Thus we might expect an increase in water rate of 13 × .075 or approximately 1.0 lb. when dropping the vacuum from 27.5 to 26 in.

R. S. JULSRUD.

Harmon-on-Hudson, N. Y.

The Rankine Cycle Efficiency can be determined from the Mollier Diagram without making any assumption, and the new water rate may be found as follows (for single-stage turbine):

Assuming F. C. D. to possess a Mollier Diagram, he may solve his problem as follows:

Starting at the top with 250 lb. per sq. in. ga. pressure, 150 deg. F. superheat, the total heat in the steam equals ..... 1290.4 B.t.u.

Projecting vertically downward to 27.5 in. vacuum, (2.49 lb. per sq. in. abs., the total heat equals..... 950.0 B.t.u.

B.t.u. drop equals..... 340.4 B.t.u.

Since there are 2545 B.t.u. per kw-hr. at 100 per cent efficiency,

2545/13 = 196 B.t.u. converted into power

R.C.E. = 196/340.4 = 57.5 per cent.

At 26 in. vacuum (3.99 lb. per sq. in. abs.) on the same vertical, total heat = 976 B.t.u. per lb.

B.t.u. drop now = 1290.4 — 976.0 = 314.4.

The new water rate = 2545/(314.4 × 0.575) = 14.1 lb. per kw-hr.

A simpler method, without introducing the R.C.E., is as follows:

New W. R. = 13 × 340.4/314.4 = 14.1 lb. per kw-hr.

ALFRED W. FOX.

Westbury, N. Y.

Comment and Criticism Invited

The chart shown at the lower part of the opposite page is presented for comment and criticism. It was devised by Marvin Castleberry, Jr. of Springfield, Mo. In his letter to us, Mr. Castleberry informs us that the graph was constructed as an aid determining the operating efficiency (heat rate transfer) of a 14,000 sq. ft. surface condenser serving a 6000-kw. turbogenerator. The characteristics of this machine were considered when calculating the heat transfer line.

The logarithmic mean temperature difference calculations have a range sufficient to be used with the usual temperatures found in operation of a turbine serving surface type steam condensers. The formula used in determining the M. T. D. chart was

$$LMTD = \frac{T_2 - T_1}{2.3 \log. [(Ts - T_1) \div (Ts - T_2)]}$$

where T_1 and T_2 are the temperatures in deg. F. of the inlet and outlet cooling water respectively. Ts is the exhaust steam temperature in deg. F. (to the referred vacuum).

In determining the value of "U" (heat transfer coefficient) Mr. Castleberry used the formula

$$U = \frac{W \cdot L}{S \cdot LMTD}$$

where W = weight of steam condensed in lb. per hr. L = the latent heat per pound of steam. 950 B.t.u. was used throughout the calculations for the given conditions. S = the condensing surface, sq. ft. (on outside of tubes). LMTD = Logarithmic mean temperature difference.

It must be understood that this chart was designed for use with a particular condenser and a particular 6000 kw. turbine. Comments and criticism on the principle involved in its use or suggestions for extending its scope to fit general conditions are invited.

Our Error

OUR ATTENTION has been directed to the fact that the captions under the two charts on p. 93 of the May issue were transposed. The upper chart gives the water rates for non-condensing turbines and the lower one is for condensing turbines. The error is obvious but we apologize for our carelessness.

LETTERS AND COMMENTS

Mingle on Chimneys

IN HIS LETTER on p. 87 of the February issue, Mr. Grover brings to an issue a practice which has resulted in more grief, draft troubles and low economy of operation in and around a steam plant installation than all others put together—specifically use of Kent's Table of Chimney Sizes for Commercial Boiler Horsepowers for the selection of chimney sizes which, to put it mildly, has been outmoded by present day practice.

A natural-draft chimney, to all intents and purposes, may be considered as an air pump, similar to an induced draft fan.[1] It has operating characteristics which are similar in all respects to those of centrifugal fans and blowers and centrifugal pumps. Since the operating characteristics of a natural-draft chimney are similar to those of centrifugal fans and pumps, the selection of the required size of a chimney involves not only a definite knowledge of the chimney-gas temperature, the mean atmospheric temperature, the unit weight of the gases, the elevation of the plant above sea level, the friction coefficient and the amount of gases to be delivered, but also the total dynamic draft against which the chimney is to operate.

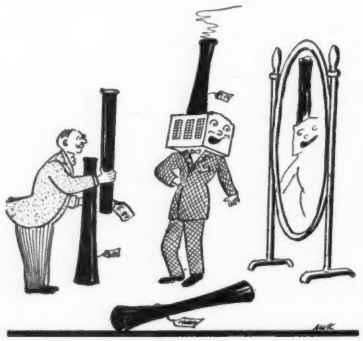
Kent's table is incomplete because it does not take into account the total dynamic draft (which is the sum of all of the resistances in the path of the gases outside of the chimney itself and includes the draft losses through the fuel bed and grates, boilers and settings, recuperators, breeching and the losses due to turns and bends, enlargement and contraction of openings and areas and the draft loss due to velocity). It is no more possible to select a chimney of a proper size for a set of operating conditions without knowing the amount of draft losses against which it is to operate, than it is possible to select a fan or a pump of a proper size without the knowledge of the total dynamic draft, or total dynamic head, respectively, against which the fan or pump are to operate.

[1]This idea was developed fully by Mr. Mingle in an article which appeared on p. 245 of the April 1939 issue of Power Plant Engineering.

Kent's table is indefinite because it does not consider the temperature of the gases, the unit weight of the gases, the friction coefficient, the atmospheric temperature nor the elevation of the plant above sea level. Each of these factors has a definite influence upon the size of chimney required. Neglect of, or a wrong guess on, any one of these factors will result in an improper size.

Kent's table is inaccurate because it is based on the erroneous assumption that the draft of a chimney varies as the square root of the height. Both the theoretical and the available draft of a chimney vary directly as the height and not as the square root of the height. The available draft of a chimney varies directly as the chimney-gas temperature, inversely as the atmospheric temperature, inversely as the square of the amount of gases flowing, directly as the atmospheric pressure or inversely as the altitude, and directly as the total dynamic draft. The available draft also varies inversely as the fifth power of the diameter of the chimney.

Kent's table is based on a so-called "effective area," assuming a core of gases flowing through an area equivalent to the total area of the chimney less a 2 in. layer of gases adjacent to the chimney walls which has no velocity. This assumption is directly contrary to the theory of the continuity of flow and also the theory of turbulent motion as expressed by Fanning's equation.



The problem of selecting a chimney

Kent's table is also indefinite because it is based on the commercial horsepower of the boiler, or boilers, which it serves. In the first place, no consideration has been taken of the draft loss through the boiler or fuel bed, both of which vary between immensely wide limits. Draft losses through a boiler vary as the number of passes in the boiler, the arrangement of the setting, the arrangement and number of the baffles, the size and length of the tubes, the number of rows of tubes in height, and so on. The draft loss through the fuel bed varies as the character of the fuel, the rate of combustion, the grade of the fuel, and numberless other factors. In the second place, the commercial horsepower of the boilers gives no queue as to the amount of gases involved insofar as the chimney is concerned.

The table states that a maximum of 5 lb. of coal per boiler horsepower per hour should be used for maximum conditions. While this definitely fixes the amount of coal burned per hour, it does not determine the total amount of gases involved per unit of time. The amount of gases which the chimney is to deliver should be figured from the furnace performance and the excess air requirement. The temperature of the gases also has a direct bearing on the required height, but has no influence on the diameter in average practice.

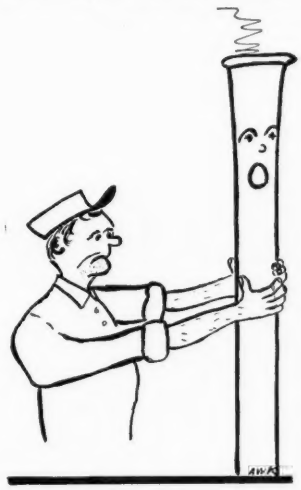
Mr. Grover also states that Kent's table involves every variable element. It does not involve the temperature and density of the gases, the temperature and density of the atmosphere, the altitude of the plant nor the total dynamic draft. It does involve the amount of gases to be delivered in a very indirect manner.

Again he states that the draft of a stack is a "forcing" and not a "pulling" power. A stack is similar in all respects to an induced draft fan, which "pulls" the gases from the boiler as contrasted with a forced draft fan which "forces" them from the installation. If a stack had what Mr. Grover calls "forcing" power, it would be similar to a forced draft fan and necessarily would be placed in front of the boilers and not behind them. Again, it is necessary that the hot gases rise before the cold air can rush in to take their place. Natural-draft is produced by aspiration, or suction, and tends to produce a vacuum while forced draft is produced by exhaustion, or blowing, and tends to produce a plenum.

Mr. Grover also states: "So far as smoke is concerned, that is the least of the job of making an economical stack." The answer to that statement is that an economical stack will do far more than a selection from Kent's table towards the elimination of smoke. An economical sized stack will have the proper height and diameter to perform properly under the maximum requirements. Also under reduced capacity requirements when it is necessary to use the damper, an economical size chimney will develop less draft than any selection from Kent's table.

Throttling a chimney by means of a damper is similar to throttling the dis-

charge of a centrifugal pump, the capacity decreases, but the head, or draft, increases. The objective is to have the available draft of a chimney increase as little as possible when it is throttled and this is accomplished as well as is possible



It should not be necessary to throttle chimneys

by an economical sized stack. The draft-capacity of an economical sized chimney is a steep characteristic, similar in all respects to a steep characteristic of a centrifugal pump where the capacity variations are small with wide variations in the head, or vice versa.

When wide variations in operation are anticipated, it is foolish to provide for them by means of a natural-draft chimney alone. The chimney height should be selected for normal operating conditions only and an auxiliary in the form of an induced draft, or a forced draft fan, should be used for conditions greater than normal. In all cases the chimney diameter should be sufficient to accommodate the gases under all conditions of operation. With this arrangement, it will not be necessary to throttle the chimney which has been selected for the maximum conditions to properly operate under the reduced conditions.

I am grateful to Mr. Grover for his criticism of my article. My only hope is that this discussion which his criticism has provoked will lead to better selected chimney sizes[2] and that "smoke stacks" will soon be a thing of the past.

J. G. MINGLE

[2]Mr. Mingle's article which precipitated this discussion appeared on page 66 of the December 1940 issue. His table of recommended chimney sizes differed in form from Kent's well known table. As a result there has been some confusion in its use and application by readers and in reply to requests Mr. Mingle has prepared a new table, in the same form as Kent's, and which will appear in an early issue.

More About Engineers and What They Ain't

THE ARTICLE "Engineers, and What They Ain't" in the April issue of PE&E is very interesting, and brings out many pertinent points. As to the inventive genious of the savage, of course it is instinctive. All men, and many animals and insects are natural engineers and mechanics. Witness bee-hives, ant hills, bird nests, beaver dams, and the instinct that motivates your own youngsters to run to gain momentum so that they can jump the creek, vault the hurdle, coast their sleds, or engage in other youthful activities. I have neither praise nor condemnation for such natural exhibitions.

To me, the article presents a very natural question. "Why don't more engineers make a name for themselves? Why don't they 'get ahead'?" Well, one very good version is amply illustrated in the article as the case is set forth by the author. "One Who Ain't." No person who enters the engineering profession for the romance it may hold will make a good engineer. Such type of person shows, by his manner of thinking, that he does not see the realities of life. As he does not see, he cannot meet, or overcome them. (Let me digress. What valid reason is there for fighting off the wenches, or the demon rum? Surely, each has a special allure.)

The writer thinks that one very real reason more "engineers" do not advance, is simply that they do not have brains enough, or if they do, they do not make use of them. There probably is not one person in a hundred that has sufficient mentality to take full advantage of a college education.

Men vary as much mentally as they do physically. Even as I can lift X physical pounds, so can I lift X mental pounds. And, surely, others can lift ½X lb., or, perhaps 10X lb. to my one X lb. To see a vast amount of money, and what is more important, time, wasted on the average person is deplorable. A grave injustice is done to the very intelligent, by retarding them, and a more grave injustice is done those of average minds by forcing them beyond their own capacity. Then we have the pencil pushers, the chair warmers, so well described by "One Who Ain't."

One of our halls of learning (I walked thru' marble halls) issued one of civilizations gravest problems, men schooled beyond their inherent intelligence. Are they educated? Of course not. They have the knowledge, but they cannot apply it. Their world is their oyster, but they cannot crack the shell. They know all the answers, but they cannot place them.

A few months since, while hunting on the farm of a Polish friend of mine, I noticed that he was in trouble with his tractor. After some investigation, we had the engine purring smoothly, and Anton, master farmer, spoke up. I had noticed him watching me closely as I worked and as I have great respect for the words of this "illiterate, uneducated farmer," I listened closely to what he had to say.

"Sam, I like to see man work with hands. These days, many men too educate to know how to make living. Summertime, college boy come thru' here, look for work. No can pull tit, no can handle bull, no can dig hole in dirt. No, man have too much book, know too much to make living." Swinging his sturdy body to the saddle of the "cat," off he went, noisy and happy, and truly educated, altho' he cannot read or write any language. There is your answer in a nutshell.

Just what is learned in college by the average student? Is he taught the reality of existence? Or what? I have a friend, with sheepskin and all, who deplores the waste of time devoted to fine arts. God in Heaven, can one stand and gaze at the work of that master bridge builder, Joseph Strauss, and not see in the Golden Gate Span the very Zenith of fine art? Is not 4 yr. of intensive education wasted on such a mind? So lacking in imagination?

We have before us in the world today, the most profound and interesting of problems, economical, social, and technical. What an array of posers! What a bed of oysters for the mental gastronomical delight of a real intellectual! What a challenge!

Examine the direct current transmission system worked out by some scientists. There is a problem. If you think that you can get somewhere along that line, dig right in, they'd be glad to have you, if you came with open mind, with energy and vision. And because you like the work, and not because of potential romance. Because it is your life's desire to explore the realm of natural laws, because you put financial remuneration to the rear of real achievement.

However, the graduate approaches these problems with the will to conquer, rather than the will to serve. He does not realize that what he gets from life is in direct proportion to what he gives to life. From the lofty, snobbish pinnacle of knowledge (To which some overworked, underpaid professor has booted him) he looks down upon the ordinary mortal and scorns work with his hands. He considers his slide rule a fiery sword with which to slay the dragon, rather that a strictly utilitarian tool with which to save time. How can we blame the company or management for this attitude? Certainly he ended his career in a routine job. Why not? Hasn't he a routine mind? Unfortunately for himself and for society, he is the product of a civilization that teaches us that financial gain is the criterion of success. All his energies have been devoted to that end. And he has fallen by the wayside. It is unlikely that he will ever learn the art of gracious living. He wanders, forlorn, in an intellectual desert, and not knowing of it, does not seek the oasis of mental peace. May God help him, and forgive those who have caused his plight.

The writer? Well, he never got anywhere because of the reasons outlined above—he hasn't brains enough—and, like Henry Thoreau, he finally got his feet down thru' the mud and mire of life to the bed rock of reality, so that he knows where he stands.

SAM WILLIAMS

I most heartily agree with what is said in the article "Engineers and What They Ain't." But as I look back across nearly 70 yr. and realize I have lived through the greatest period of the history of the world, and engineering, I feel there are some angles of the subject which the writer failed to touch on.

Holy Writ informs us that "Jeremiah" was troubled with the same apprehension when he writes, "My people have forsaken me, and have hoven them out cisterns. Broken cisterns that can hold no water." What a true picture of the lives of a vast majority of engineering graduates today.

I sometimes wonder if the price we must give for the big jobs is worth it, after all. To illustrate my point, years ago I helped to dig the first trench and erect the building of one of the great electric manufacturing plants. When we had the machinery set ready to go the owner took several of us boys into his laboratory, but my restless nature wouldn't permit me to stay put. So I left to go firing a locomotive, while the boys who stuck to the job all accumulated several million dollars, but they are all dead while I have never been sick enough to have a doctor in my life, am working harder than ever and get the greatest pleasure and enjoyment out of every moment of my work. I still have enough conceit to believe I could get almost any job from my present firm that I would care to ask for. There are many good engineering jobs floating around if one is fortunate enough to get one and the method of getting them is answered in "Ecclesiastes":

"I saw that the race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding, nor yet favor to men of skill, but time and chance happeneth to them all, for man knoweth not his time." So why get steamed up about a $10,000 a year job when we can enjoy life on less?

An engineering training is a good foundation for any kind of business, so if we find we are up a blind alley why not start a "roadside soup kitchen" or a fancy little "roadside farm". Two of the boys who were graduated with me are doing that and are making more money than any of the ones who followed engineering.

The one thing we must keep in mind is that world conditions have almost entirely changed the last few years. We have become a part of a great machine which only allows us to go so far and so fast.

With all kinds of business being more and more subjected to government regulation which inevitably will affect the engineering profession. It seems as if we have almost reached a point where everyone will be compelled to work and earn enough for an existence but no more, regardless of one's ability. This is not a pleasant thing to think about, but it surely does seem as if that is what the future holds for us unless we form ourselves into an organization like all other human activities are doing.

Regardless of what happens the engineer will remain always unvanquished, which may be summed up in the following:

I have planned, and hoped, and striven
To the will to do I have added the deed,
Of my best talents I have given,
Then prayed, but God did not heed.
I am old, and bent, and have been cheated
Of all when young I hoped to win.
But list me not with the defeated,
For tomorrow I start anew again.
I am an engineer.

HORACE S. BRACKEN

Johnstown, Pa.

I read the article, "Engineers and What They Ain't," and the comment on it is with very much interest, as we have a Cadet in our family. I couldn't see so much dynamite in the thing except for many of the "Sons of Martha". I would say you stuck a pin right into that big bump of ego and naturally they yell because when one has to go as far back as when the Lord and his Mother were on this earth to try to find a reason for sitting around and not getting anywhere, that's a honey.

I made sure that the article would be read by this Cadet because I wanted his reaction. So I showed him the article. When he came to the part about the movies he laughed and said, "Darned if that wasn't my idea too." When he finished I said, "Well?" "Well," he said, "that ought to make the president's daughter a very popular girl." What about the getting "pigeon holed?" I asked. "There is a possibility," he replied, "but my object is to stay in the 'Top 10' in my class; so far I haven't been worse than 5th and if I can't get attention that way I still have a year to make up my mind and I could go to Michigan in that year and get my M.A. That would make me, well, not so right-handed so to speak, but would open up the field. However, I still stand a chance of getting pigeon holed but I might be able to fur-line it a little, which would make it more comfortable."

Well, you can imagine that I was pleasantly surprised by that kind of an answer from one whom I always considered just a kid. My eyes popped. Then I started to think, why not? The schooling that he has, etc., gee, but this sure is a great country to live in. Where in the world would any one get such a chance. Not only to work at a good job but trained to make it better. Trained to think. Some countries seem to think it is bad for the country when people start to think. What those boys wouldn't give to get pigeon holed in one of our jobs, or any job that would make enough money for their family to have a home, built like and furnished like that of one of our poor pigeon holed boys. My thought is "God Bless America".

So in closing I want to say to all the Sons of Martha who think because they have a degree that they can sit at the feet of the world and gloat, Martha's gone and so will the world if they don't wake up. When Martha was here men with degrees were looked up to and pointed out, but in America where everyone gets his chance to shine, men with degrees haven't lost a thing, but they have to keep moving because the road is getting crowded; they no longer stand out alone in a crowd because they are standing in a crowd of boys who have a degree as good as theirs. The boy who stands out today is the boy who doesn't train for something. He's the boy who is all by himself.

So, as James O. G. Gibbons said, "Blood, sweat and tears go into the make-up of things worth while." To that I want to add this, "Nothing for nothing and very little for a dollar." Or you get what you pay for and pay for what you get. Give nothing and you receive nothing.

Well, Mr. Editor, I started out to tell you what a Cadet's reaction to the article was, but I got going on one of my pet peeves. There are a lot of men who go to college and think they have done a great thing and want to know what the world is going to *give* them for doing that. I say they have got a lot to learn before they get through. They should take their knowledge as a man would his tools and do a good job. The man with the dull tools turns out a ragged job. So does the man that lets his knowledge get dull and doesn't stay up on his study and keep abreast of the times. It's work and more work, no matter how you put it.

HAROLD E. GETHOEFER

Buffalo, N. Y.

What About Bronze?

I HAVE read with interest the article in the April 1941 issue of POWER PLANT ENGINEERING entitled "What About Bronze?" although I am confused after a study of the material presented. The author makes no attempt to distinguish between brass and bronze and it was not until the end of the article (even with the help of the footnotes) that I could guess he was talking about bronze and not brass. The author apparently assumed his reader to be an expert on non-ferrous metals and yet did not give him credit for knowing some of the elementary uses of these materials. More reader interest would have been gained by describing in detail some of the unusual ways in which bronze has been used.

The manufacturers and fabricators add to the confusion concerning these two metals because of the loose way the

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terms brass and bronze are used. For that reason I had expected to get some information from the article which would be of use in distinguishing these two metals. The footnotes on page 102 were of considerable help in this matter and it seems to me would have added clarity to the text had the author included such material.

Incidentally, the analysis given for Admiralty metal in footnote No. 2 does not agree with the analysis given by a large manufacturer of non-ferrous products. The 88 per cent copper, 10 per cent tin and 2 per cent zinc sounds like a very special alloy as contrasted with the above manufacturer's analysis of 70 per cent copper, 29 per cent zinc and 1 per cent tin for Admiralty metal.

GEORGE E. MARLEY

New York, N. Y.

It Pays to Listen

IN READING Mr. Pawlowski's letter, I find just one thing wrong with it, and that is the "whole thing". One thing must be assumed in making any such comparison, and that is that each man must have the same latent qualities. To do otherwise is no comparison at all. By this I mean that some men are born engineers, while others would never make engineers even though they were graduated from every college in the country; you'll have to agree on this point.

As far as the young man having the advantage over the Old Timer, I have never heard of a company refusing to send helpful literature to an Old Timer. It is equally available to all of us. (Note the oft-printed business reply card in P.P.E. Does it say, "Available only to young men"? I should say not.)

I think I can answer Matt's whole letter by asking just one question, "If the young fellows are so damned smart, why don't company executives and boards of directors snatch them up for all the important positions in their own company?" There is just one answer and that is "Experience."

By the way, Matt, I am a young squirt who has found that sometimes it pays to listen.

ARTHUR F. CHURCHILL

Connection and Installation of Ground Detectors

(Continued from Page 89)

the resistance should be varied until all lamps burn the same brilliancy. The resistance should be increased until the lamps go out and then decreased until little more than a faint glow is detected. If this regulation is made, three advantages are obtained: 1. the power used by the detector is so small that it is negligible (from about 3 to 5 watts in a 7.5 watt lamp), 2. maximum sensitivity of the detector is obtained, since a ground that will cause very little indication in the lights connected to the faulted phase will cause the detector lamp to go out, and, 3. the lamps will last several times as long as they would if burning at full brilliancy.

Figure 2 shows the detector as applied to the three-phase delta system commonly used in nearly all factories that are large enough to have separate transformers to feed power and lights. The line-to-line voltage in this system may be almost anything from 220 and up. The usual value is 220 or 440. If 220 v. are used, the ground detector should consist of two 115-v. lamps or one 220-v. lamp where the one lamp is indicated on each line in Fig. 2. If 440 v. are used, two 220-v. lamps should be used.

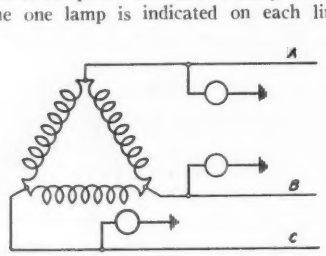

Fig. 2

An examination of Fig. 2 shows that under normal operation, every lamp has only half its rated voltage applied to it. For this reason, variable resistances will probably not be necessary, although they could be used, possibly to advantage. Should a ground fault occur on any of the lines, the fault will short-circuit the lamp connected to that line and put it out. This condition also puts full voltage across the lamps connected to the other two lines and they will brighten considerably, possibly to full brilliancy if the ground fault is severe enough.

In Fig. 3 is shown a 3-phase star (or wye) connected supply which is being used more extensively today and may some day replace the unbalanced delta system as a feed for power and lights. Where separate transformers are used for power and light supply, this connection may be used to supply the lights. Where it is used to supply lighting systems, the neutral, N, must be grounded, but if it is used for power alone, the neutral need not be grounded. The voltage between lines is approximately 1.732 times the voltage from phase to neutral under normal operating conditions. The voltage usually used from line to neutral for lighting or for combined power and lighting supplies is 120 so that the line-to-line voltage is 208. In practice, both 115-v. lighting and 220-v. power systems work very well from those voltages. When the star is used for power only, the line-to-line voltage may be either 220 or 440. The voltage from line to neutral is then 191 on the 220-v. system and 382 on the 440-v. system.

The detector system shown in Fig. 3 can be applied to any star system, whether the neutral point, N, is grounded or not. The voltage ratings of the lamps should add up to the line-to-line voltage. Variable resistors can be connected and adjusted as explained for the unbalanced neutral system.

In the star, a ground fault on any line will short-circuit the lamps connected to that phase and cause the lamps

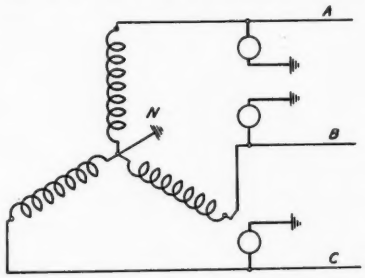

Fig. 3

connected to the other lines to become brighter. The increase in brilliance of these lamps depends on the severity of the ground fault and the relative unbalance on the two unfaulted lines. If the fault is severe enough, the voltage from line to neutral on the unfaulted lines may be twice normal. The results will be similar regardless of whether the neutral is grounded. With the neutral grounded, however, the lamps on the unfaulted lines may light more brilliantly when a fault occurs because of the unbalanced relationships caused by short-circuiting one phase of the transformer. This unbalance may not be as great with the neutral ungrounded if only one accidental ground occurs.

The detector lamps in all three systems should be placed in the electrical repair shop so that they can be seen the instant a ground fault occurs. If the plant is shut down for any period with no repairmen on hand, a set of detector lamps should be placed on the route of the night watchman so that he can see them on every inspection trip. He should be taught to notify a proper official and report the indications should a ground occur. Arrangements should be made to call a repairman to trace and clear the ground as soon as possible.

Should the normal voltages on the system used in the plant be higher than 440-v., an alternate connection would be to connect step-down transformers from line to ground, connecting the lamp in series with a variable resistor across the secondary of the transformer. Care should be taken to use lamps of the proper voltage rating. The brilliance of the lamps can be regulated as before. All indications will be identical with those of the lower voltage systems with lamps directly connected.

Care should be especially taken when connecting a ground detector that the ground connection is direct and solid to ground. Any appreciable resistance in this connection may completely nullify all of the advantages that might otherwise be gained from it.

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Fig. 1640
150 lb. S. P.
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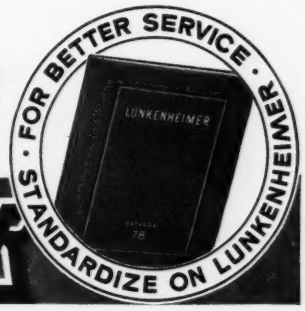
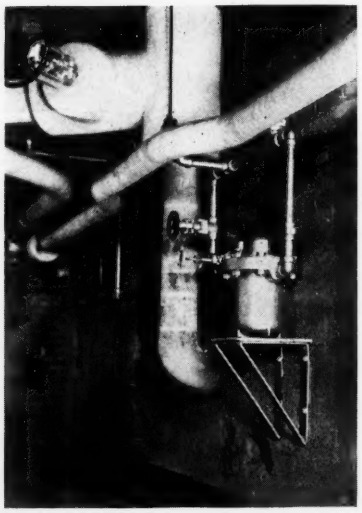


LUNKENHEIMER

SHOP TALK

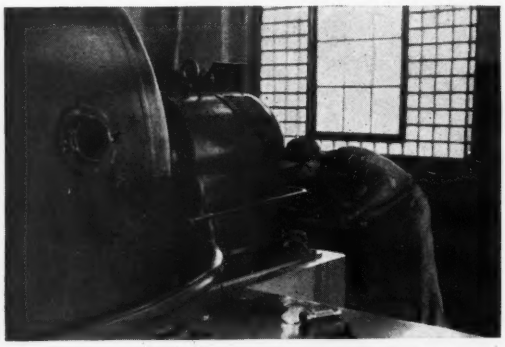
A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.

WHY ENGINES GO BAD—Soft non-scaling jacket water is recognized as a necessity today but softeners alone cannot do the job unless they are operated properly. This photograph shows two Diesel cylinder liners recently removed from an engine after several years operation. Scale peels off in sheets 6 or 8 in. square and about $\frac{1}{16}$ in. thick. In some places the scale had built up to well over $\frac{1}{4}$ in. thick, practically closing some of the ports. The necessity for attention to the characteristics of jacket water is quite obvious from this photograph.



TRAP SUPPORT—Traps should be accessible yet out of the way and this has been done very handily in the Hobart Mfg. Co. plant at Troy, O., by means of angle iron brackets.

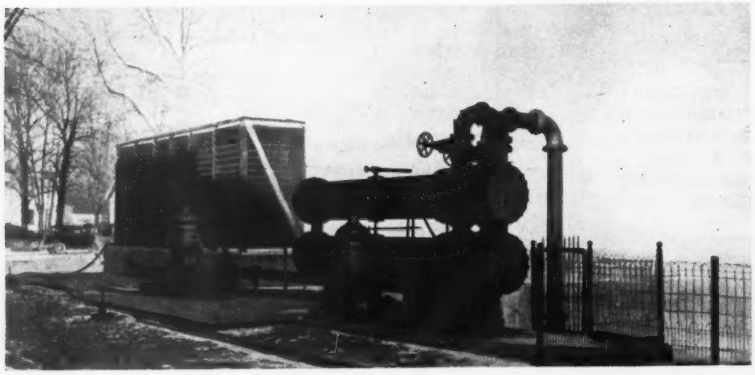
HANNIBAL, MO.—Practically in the shadow of Mark Twain's old home, where Tom Sawyer, Huck Finn and Becky Thatcher are more than ghosts of a by-gone era, the municipal power plant at Hannibal, Mo., is a model of good housekeeping. The portable vacuum sweeper is used to good advantage, and here the operator is using it to clean the carbon dust from the exciter while the brushes are being replaced. Glen Geyer is chief engineer of the station and William Watson superintendent of the department.

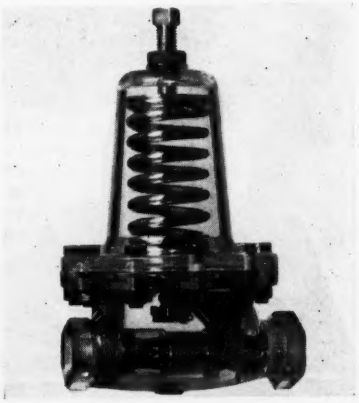


PLASTICS FOR MODELS—New transparent plastics such as Lucite and Plexiglas have been used for every conceivable purpose from modern furniture to cocktail trays. From an engineering standpoint, construction of

equipment models has been one of the most interesting developments. Two of these made by The Dave Swedlow Corp. are illustrated, one is a Crosby gage, the other a Cash reducing valve. Two of the latter were made, one with the case and all interior parts of plastic, the other (illustrated) with the interior parts of metal.

HEAT EXCHANGERS—Space in the plant being at a premium, Diesel cooling water heat exchangers at the municipal Diesel power plant at Bryan, O., were installed outside adjacent to the spray pond. In the photo below notice the vertical soft and raw water pumps which fit the conditions perfectly. The structure at the left is not a cooling tower but louvers installed to reduce windage loss from the spray pond. The photograph was taken in the winter and sprays were not in operation. M. J. Miller is superintendent of the water and light department, Art Castor is chief engineer.





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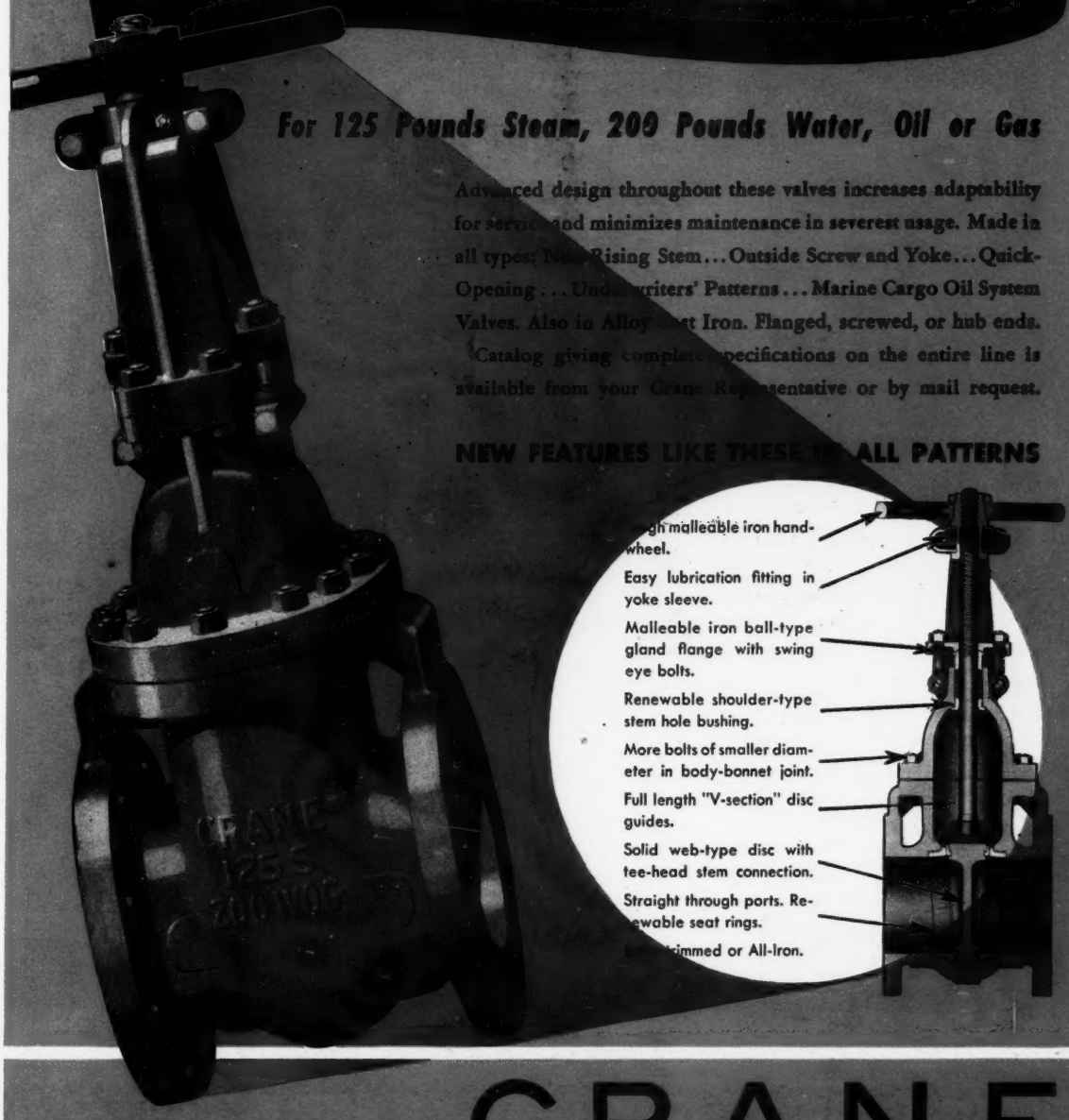
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New Equipment

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Splashproof Tri-Clad Motor

TRI-CLAD splashproof, ball-bearing, polyphase induction motors in sizes from 1 to 15 hp. have been recently announced by the General Electric Co., especially designed for use where splashing water and other liquids are present. Outstanding features include sturdy cast-iron stator frame, end shields that re-

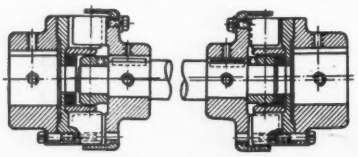
sist rust and corrosion, formex moisture-resistant wire windings and thoroughly protected ball bearings.

Ventilated openings in frame and end shields are baffled to block the entrance of liquids, with baffles in the side openings of the stator to block splashing from the side.

Windings are impregnated with special synthetic resin varnish, and have a covering coat of tough Glyptal.

Floating-Shaft Coupling

A NEW floating-shaft flexible coupling employing the L-R principle has been recently announced by the Lovejoy Flexible Coupling Co., Chicago, Ill. This new coupling, designated as L-R Type HKQ, is applicable to either horizontal or vertical drives, and is recommended for the longer distance drives where the space



OPERATING ASSEMBLY

between the driver and driven units cannot be successfully handled by standard couplings, and especially where there is excessive misalinement. The floating shaft is supported in fixed bearings entirely independent of the power-transmitting elements.

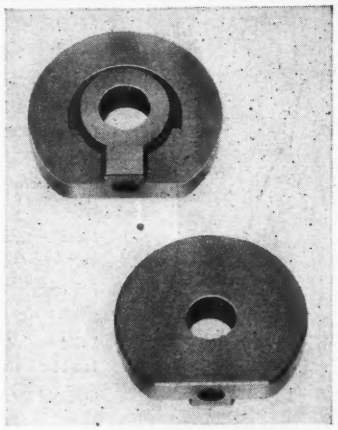
An outstanding feature of the new L-R Lovejoy Floating Shaft Flexible Coupling is said to be the speed with which it can be disassembled. Chatter caused by end-wise impact of the floating shaft against the fixed shafts is prevented by suitable cushions. Either of the coupling bodies mounted on the fixed shafts may also be used as a sheave, or part of a sheave, for V-Belt drive. When this is done, removal of the floating shaft makes removal or replacement of the V-Belt possible without disturbance of the connected machines.

L-R Type HKQ couplings are made in standard sizes, with bores from 1½ to 8½ in. (7 to 800 hp. at 100 r.p.m.), for various distances between fixed shafts, and for handling extreme misalinement.

Selflube Porous Bronze Bearings

KEYSTONE Carbon Co., St. Marys, Pa., has recently developed several new shapes and sizes for their line of Selflube porous bronze bearings.

Selflube porous bearings are made from powdered alloys, which are moulded to size in the shape desired, then baked, and finally quenched in oil. They have an average porosity of 35 per cent, enabling them to store a large amount of oil which forms a protective, continuous oil film on the bearing surface. In many instances, this oil reserve lasts the entire

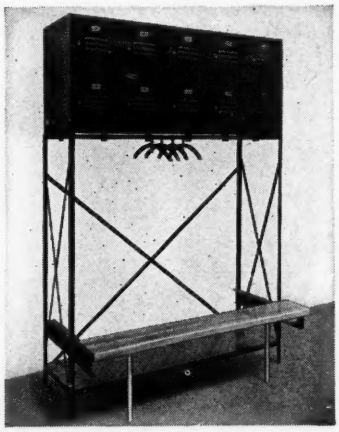


life of the application, eliminating the use of oil vents or grease cups. Additional lubrication is recommended for heavy duty or continuous operating units.

Selflube porous bronze bearings have a tensile strength of over 35,000 lb. per sq. in. Because of their high strength, these bearings will carry maximum loads without distorting or breaking, and breakage loss during installation is eliminated. They have a low friction coefficient which, together with their self-lubricating qualities, prevents excessive temperature, speed reduction, noise, and scoring of shaft. Selflube bearings are moulded to close dimensional tolerances so that no redesigning or special engineering is required.

Steel Locker Unit

PENN-KELSEY Unit recently announced by the Penn Metal Corp., Philadelphia, Pa., provides complete locker facilities for ten persons with open coat space, perforated metal shoe rack and ten locked



compartments, each 12 in. wide, 18 in. deep and 12½ in. high. Doors are flanged for strength. Locking is by flat key lock, springbolt combination, or a padlock. Each unit is 60 in. wide, 18 in. deep and 87 in. high.

Leakage and Conductivity Measurement

TWO INSTRUMENTS, one for checking leakage resistance, the other for measuring electrolytic conductivity of liquids, have been recently announced by Industrial Instruments, Inc., Jersey City, N. J. Both are based on Wheatstone bridge action but are simplified by use of the Magic Electric Eye as an indicator, in place of a galvanometer reading, and by simple controls and adjustments. For the Megabridge, to measure leakage resistance, a single dial knob is rotated until the dark angle of the eye remains unchanged when the detector button is depressed, and reading is made directly from the dial.

For the conductivity bridge, values from 0.2 to 250,000 ohms can be measured with but two adjustments. Main control changes the ratio of the bridge arms and a calibrated dial can be read directly in ohms, or in any other terms for which it may be graduated, such as parts of chlorine in 2,000,000 for water. Uses are for checking purity or condition of water, or concentration of industrial solutions. A dip cell serves to give contact with a fixed cross-section and length of solution, various types being used for different purposes.

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Infra-Red Heat Lamps

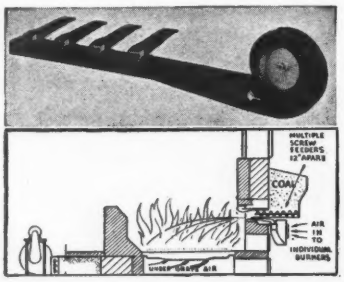
THREE NEW infra-red heat lamps were placed on the market recently by the Birdseye Division of Wabash Appliance Corp., Brooklyn, N. Y. Two of the lamps will be clear for use with the standard gold-plated or Alzac reflectors; the third will not require separate reflector since it will be built with its own reflector lining sealed inside to keep it free from oxidation and the collection of dust,

dirt and fumes. The manufacturer states that the reflector lining will keep heat-reflecting value for the 6000 hr. life of the bulb, because it will be made of pure solid silver which will be sealed inside the gas-filled bulb.

Differing from incandescent lamps used for lighting, the filaments of the infra-red lamps operate at lower temperatures, developing infra-red radiant energy at wave lengths which have high penetration. The unique property of these lamps and of infra-red radiant energy developed is the ability to penetrate deep down into the surface films of lacquers, paints and enamels to start the baking and drying process from the inside out, instantly, and uniformly.

Air Injection Manifold for Stokers

ABILITY to spread small sizes of coal in a predetermined pattern conforming to furnace grate area with less than 25 per cent plus or minus cumulative variation is claimed for a low-pressure air injection manifold developed by the



American Coal Burner Co., Chicago, Ill., for use on its line of spreader type stokers. Designed to connect to a 1750 r.p.m., low-pressure air blower, one air outlet nozzle protruding directly below each of the delivery screws of the stoker. Nozzle shape is worked out to give flat, fan-shaped spreading of coal, the blower being capable of supplying air at a maximum of 4½ in. static pressure, considerably in excess of that recommended for normal firing with small sized coal. Adjustment for various sizes of coal, wet or dry, is secured with a main manifold damper and individual dampers on each spreader nozzle.

This method of coal feeding is stated to eliminate moving parts within the high temperature part of the furnace, to automatically supply the over-fire air needed for burning coal fires in suspension, and to create turbulence in the furnace chamber favorable to high combustion efficiency. It is intended for small and medium size plants where modernization of existing furnace is desired.

Electric Test Set

SERVICEMEN and salesmen of electrical appliances, as well as electrical contractors, will find special interest in the new pocket-size appliance tester recently released by Radio City Products Co., New York, N. Y., specialists in radio and electrical test equipment.

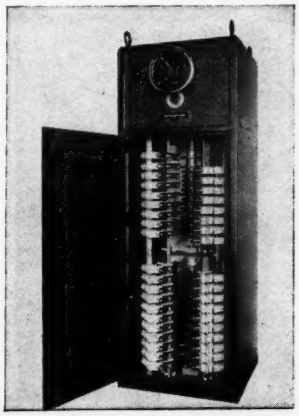
Eighteen measurement ranges are provided. These include a.c. and d.c. line voltages up to 250; four d.c. ampere ranges to 25 amp. and the same for a.c; four d.c. watt ranges to 3000 watts and duplicate a.c. ranges.

Watt ranges are direct reading where the line supply is 120 v. and power factor of the appliance unity. Curves and data supplied with the instrument permit rapid conversion for different values of voltage and power factor. The Model 417 permits direct comparison of power consumed by various appliances. This is also an excellent instrument for making power measurements of motors up to several horsepower. Contained in a neat hardwood case with etched metal panel, the overall dimensions of this instrument are 5⅞ in. long, 3¼ in. wide and 2 in. deep.

For hot jobs, Coolband to prevent sweat getting into eyes and goggles has been placed on the market by Mine Safety Appliance Co., Pittsburgh, Pa. Placed around the head, without binding, it absorbs perspiration, is stated to create a cooling effect and can be easily wrung out and disinfected.

Motor Operated Secondary Controllers

FOR USE with polyphase wound-rotor motors on fan, pump, and similar drives, a new motor operated secondary controller is announced by Westinghouse Electric and Mfg. Co.



This controller provides either 13 or 20 balanced points of control by varying the external resistance in the motor secondary winding. Enclosed in a self-supporting steel cabinet, the unit has cam-actuated contactors arranged for sequential operation in pairs from a common motor-driven cam shaft. Individual cams give "quick-make" and "quick-break" contact action. Pure silver inlays on contact surfaces assure excellent current conductivity and avoid heating due to oxidation of the copper base. Separate copper arcing contacts prevent burning or pitting of main contact surfaces.

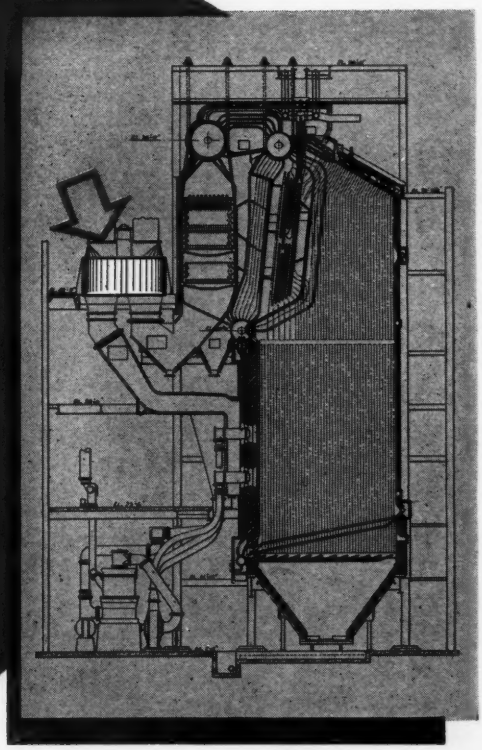
The controller drive mechanism consists of a pilot motor; a gear reduction unit, and a Geneva gear for angular movement of the cam shaft. Step-by-step action is assured by a gear and pinion arrangement to move the controller one full position or point for each gear revolution. Over-travel protection is provided by auxiliary cam-actuated switches. The motor may be supplied for 115 or 230 v. d-c and 110, 220 or 440 v. a-c.

Trigger Control Extinguisher

SPEEDIER fire fighting operation has been added to the 4 lb. carbon dioxide extinguisher recently announced by Walter Kidde and Co., Inc., Bloomfield, N. J. The trigger control valve, recently developed by this company for its 2 lb. unit is now standard equipment on the new 4 lb. type.

This extinguisher is discharged by simply pulling a trigger. This type of discharge control not only permits the

Repeat Performance "Way Down East"



Ljungstrom Air Preheaters go into action for higher heat recoveries on still another modern steam generating unit of a large New England utility company.

This modern steam generating unit, operating at 1225 lb. per sq. in. pressure, has recently gone on the line for one of New England's utility companies. As in the case of previous units installed by this company, it is equipped with Ljungstrom Air Preheaters for the final step in heat recovery. Two vertical-type heaters serve on this unit. When operated at its maximum continuous capacity rating of 430,000 lb. of steam per hr., gases enter the preheaters at 628° F. leave at 308° F., heating combustion air to 524° F.

. . . . .

When experienced operators of steam generating plants *repeat* their choice of Ljungstrom Air Preheaters on their newest high-efficiency units, as this organization has done, it furnishes the best evidence we know of the thermal efficiency and mechanical dependability of the Ljungstrom.

The fact is that more of these compact heat-transfer units, based on the *continuous regenerative counterflow* principle, are now being installed in a higher percentage of high-efficiency power-plants than ever before. *Every* leading boiler manufacturer has included them in outstanding installations made during the past year.

Straightforward engineering economics will demonstrate that the margin of advantage is definitely on the side of the Ljungstrom preheater in almost every case. If you'd like to see how the figures look for an actual installation comparable in size and operating conditions to the one you plan to build, write us today.

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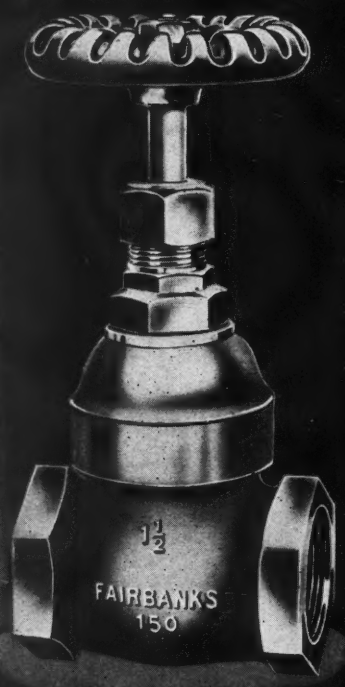

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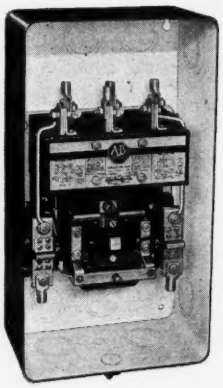
extinguisher to go into action faster, but also insures no wasting of the carbon dioxide gas while the operator is maneuvering around the blaze. When the trigger pressure is released the discharge is shut off.

The nozzle arm is equipped with a swivel, so that the discharge horn is held in a "down" position when the extinguisher is not in use.

Solenoid Starter

A NEW large solenoid switch constructed starter has recently been developed by the Allen Bradley Co., Milwaukee, Wis.

All the features of the company's smaller starters are incorporated into this new starter known as the Size 4. The use of cadmium silver contacts prevents contact cleaning, filing or dressing.

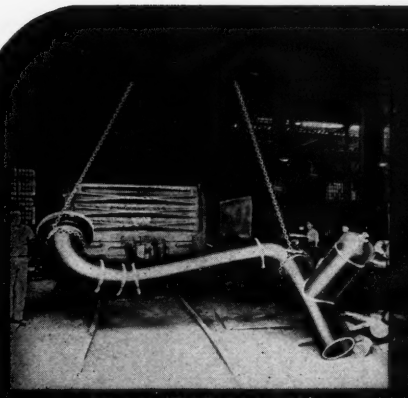


The construction is simple and free from complicated mechanisms. Wiring is made easy by plainly marked, accessible terminals and by the ample wiring space between the starter and the cabinet. The starter is mounted on a self-insulated metal base plate, which may be mounted on any metal surface without extra insulation. It can also be provided with or without an enclosure.

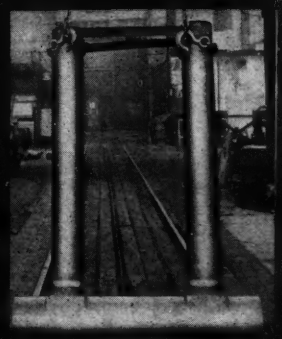
Thin Line Electric Etcher

A SMALL, new etcher for permanently marking small tools and parts is announced by the Ideal Commutator Dresser Co., Sycamore, Ill. This etcher writes with a fine line, burning the mark, identification number or name right into the metal, so it cannot become blurred or worn off with ordinary usage. All parts are fully enclosed and out of the way when not in use. Complete unit includes 9 ft. primary lead and plug, 2 oz. heat resisting hand piece with 3 ft. lead, 4 by 6 in. work plate, 115 v., 50-60 cycle standard. Other voltages and frequencies are available. Etching heat 125 watts. Weight 5¼ lb. Size only 4¼ by 4¼ by 7 in.

Hydrozo, a liquid type waterproofing for masonry has recently been announced by Hydrozo Products Co., Madison, Wis. It has been in use in cake form since 1902, but is now made in liquid form to facilitate application by brush or spray. It is said to penetrate the pores of masonry to a depth of from ¼ to ¾ in., where, after volatile evaporates, a gummy substance remains, thus providing waterproof protection which is unaffected by heat or cold.



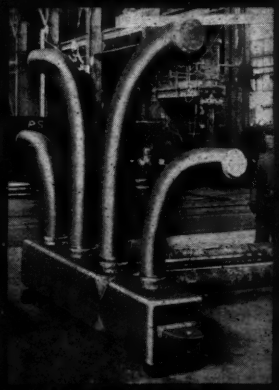
Crossover Welded Assembly for 300 lb. — 600° F



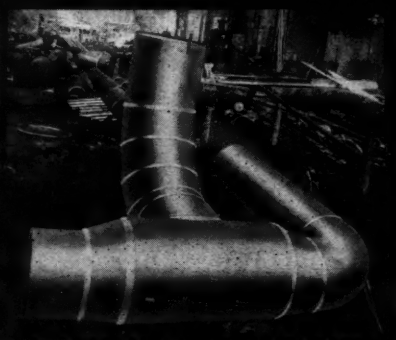
Part of High Pressure Feed Line for 1750 lb. — 450° F

Steam Header for 1250 lb. — 925° F

Forged Steel Main Header for 1350 lb. — 935° F



Main Boiler Feed for 2000 lb. — 320° F



30" Carbon Moly Assembly for Turbine Exhaust for 300 lb. — 900° F

EVERY PIECE IS A *"MASTERPIECE"* OF KELLOGG PREFABRICATION SKILL

The piping assemblies illustrated above were all prefabricated complete in the Kellogg shops and shipped ready to connect on the job.

Recently, 2,358 pieces of pipe for one job were prefabricated and welded in the Kellogg shops.

If you have a piping problem necessitating accurate prefabrications, consult a Kellogg engineer.

KELLOGG

THE M. W. KELLOGG COMPANY

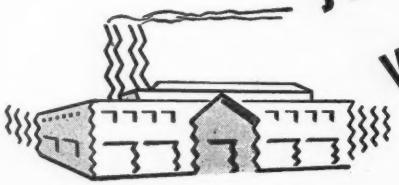
JERSEY CITY, N. J. • 225 BROADWAY, N. Y.

REPRESENTATIVES

LOS ANGELES: 609 SOUTH GRAND TULSA: PHILTOWER BLDG.

"Masterflex" Prefabricated Piping Systems • **"Masterweld"** pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Reforming, Dehydrogenation, Alkylation, Desulphurization, Thermal and Catalytic Polymerization Units • **JUIK Processes** for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

SHOCKS!
JOLTS!
VIBRATION!



BUT—

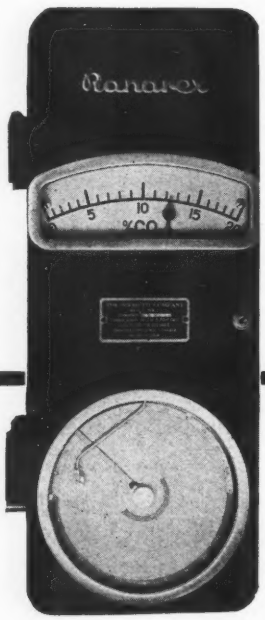
RANAREX*
can take it—because it's the only mechanical
CO_2 INDICATOR and RECORDER

★ No chemicals or fragile parts to get out of order; can be taken apart with a screwdriver.

★ Quick, accurate readings—within 3/10 of 1% CO_2. 24 hour record.

★ Big savings on fuel costs—as high as 20%.

★ Operates on ordinary lighting circuit.



Ranarex is also available in the new portable model... having all the toughness and accuracy of the standard, yet weighing less than a typewriter!

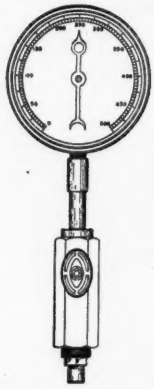
Write for free booklet, giving complete data. Address: The Permutit Company, Dept. A1, 330 West 42nd Street, New York, N. Y.

* Trademark Reg. U. S. Pat. Off.

product of
PERMUTIT

Micro-Action Valve

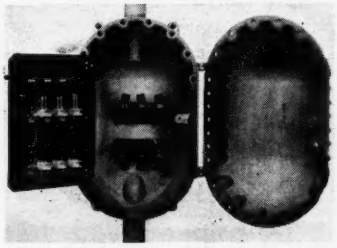
FOR DAMPENING pulsation of boiler plant pump governors and to eliminate jitters of the gage hand, a novel device known as the Campbell Micro-Bean has been recently developed by J. A. Campbell Co., Long Beach, Cal. It can be installed on the pressure line to the diaphragm of a pump governor for protection of the gage mechanism and tube, also the spring, diaphragm and



stem packing. It also protects any control valve, such as a back pressure or reducing regulator and sensitive control instruments subjected to pulsating flow. The valve will handle steam, fuel, oil, gas, water or other liquids, with adjustment for each viscosity. The Micro-Bean has a solid brass body with filter inserted for protection from foreign matter, and a valve of extremely slight taper, 48 to 1, to give sensitive control of the shut-off. It is applicable for pressures up to 3000 p.s.i.

Enclosed Case for Circuit Breakers

STREAMLINED enclosing case for Type AE-1 air circuit breakers of 15,000 and 20,000 amp. has been recently announced by General Electric Co. Finish is of

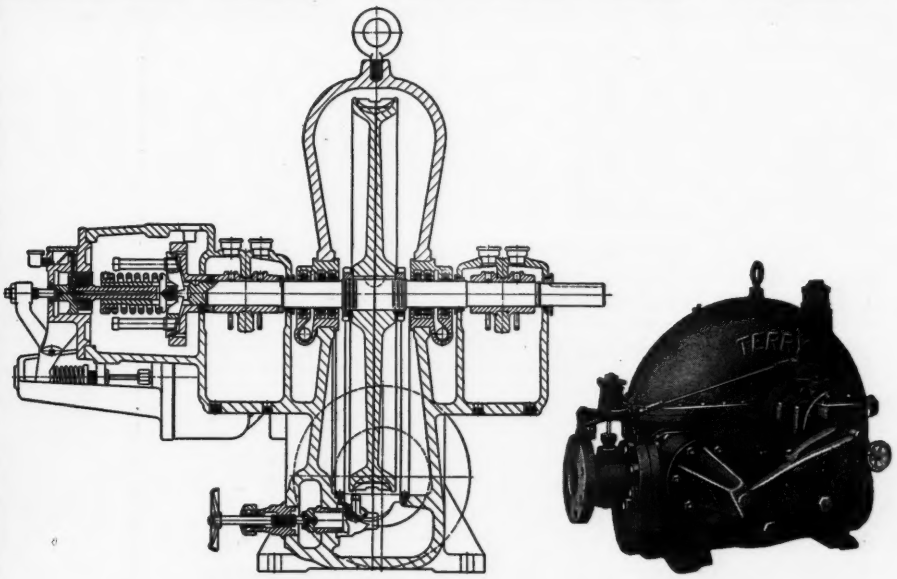


metallic bronze; the cover is dustproof and has four latches which can be padlocked. The case is bolted to the wall and connected to cables by solderless terminals. The breaker unit is placed on brackets and engaged by finger contacts with stationary studs.

Self-Supporting Aerial Cable

TWO NEW types of self-supporting aerial cable for use on urban, suburban, and rural power circuits in place of bare weatherproof, tree wire, or cable on messengers, have been announced by the General Electric Co. The new cables, designated SS, are of the 4- and multiple-conductor type, supplementing the 2 conductor type recently introduced.

TERRY



For Year After Year Service — The Terry Solid Wheel Turbine

The Terry Solid Wheel Turbine employs a one piece steel wheel. The buckets are milled from the solid metal. There are no parts to become loose or to work out.

The blades have large clearances and are double rim protected. End play cannot damage the blading and it is impossible for it to foul.

The power producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets and therefore close blade clearance is not necessary.

Terry Solid Wheel Turbines are available in ratings from 5 HP to 2000 HP and are built for all commercial steam pressure and exhaust pressures. They are described in our bulletin S-116. A request on your business letterhead will bring a copy.

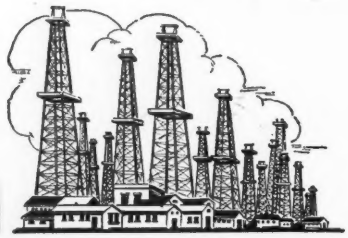
Above: Cross section of typical Terry Solid Wheel Turbine.

T-1141

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

★ THERE'S A BELMONT PACKING FOR EVERY SERVICE ★

FOR OIL



NOW, when every production minute has an increased value, no plant can afford to have unnecessary delays and equipment failures caused by inadequate packings. That's why it is important to pack with Belmont—the packings that are pre-planned for service.

Below are two of the many Belmont Packings especially made for Oil Services, packings that will perform their tasks faithfully—even under the strain of 24-hour-day operations. Both Belmont 6100 and 189 are made from selected high grade asbestos yarn, braided, and treated with an exclusive lubricant for ultimate wear and greater efficiency.

The complete line of Belmont Packings (for all types of services) is illustrated and described in detail in Belmont Catalog No. 40. Write for a FREE copy on your company letterhead today! Any Belmont distributor will be glad to show you samples and help you with your particular packing requirements.

BELMONT PACKINGS

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

FOR
GASOLINE SERVICE
BELMONT 6100
For rod and valve stems handling volatile distillates such as gasoline, kerosene, naphtha, and benzol.
FOR
HOT OIL SERVICE
BELMONT 189
For rods and plungers handling hot or cold oil—all temperatures.

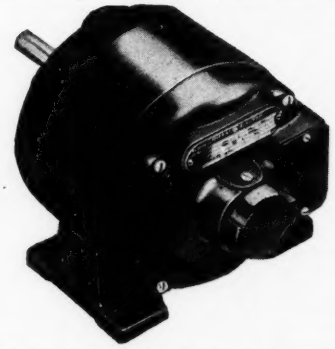
THE BELMONT PACKING & RUBBER COMPANY
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

The characteristic and distinctive feature of the new cable is its outer covering, consisting of galvanized steel wires for mechanical strength, interwound with electric conducting wires of copper.

The 2-conductor type is for single-phase circuits with one side grounded, from 4000 up to 15,000 v. The 4-conductor type is for 3-phase, 4-wire circuits with grounded neutral, up to 5000 v. Each of these types has No. 1799 varnished-cambric insulation, with the ground-return conductor in the outer covering.

Small Motor for Machine Tools

FOR FREQUENT start-stop service where metal dust is encountered, General Electric Co. has introduced a new line of ¼, ⅓, ½ and ¾-hp. motors for 3-phase and d.c. systems, with Formex wire in-



sulation, ball bearings and one-piece cast-aluminum rotor. Stator has firmly anchored windings to withstand momentary overloads from plugging. Mounting may be at any angle by flange, flat-face or rabbeted connection.

Oil Developed for Diesel Engines

WHEN THE maximum speed of Diesel engines was 200 to 300 r.p.m. and pressures did not exceed 500 lb. per sq. in., engineers experienced little difficulty with lubrication. Conditions changed, however, when speeds advanced to 1800 or 2000 r.p.m. and maximum pressures reached 700 to 900 lb. per sq. in. Under such service conditions, oil oxidation developed various acid and oxygen compounds, many of which were resinous in nature with a tendency to form sticky, gummy deposits in the engine, commonly known as varnish, as well as sludge.

Tackling the problem from the operator's side of the ledger the Valvoline Oil Co. of Cincinnati, Ohio, has for a number of years carried on research work in the field and laboratory in order to develop a satisfactory oil for lubricating Diesel engines operating under modern high speed and pressure conditions. These efforts have resulted in a successful Pennsylvania lubricant for Diesels and gasoline engines operating at peak loads that has been named "HPO" (a contraction of High Power Output).

It is a lubricant with a high viscosity index (105-110), engineered especially to minimize costly repairs caused by oil oxidation and to overcome other lubricating failures which have been common in heavy duty operation. A distinct feature of "HPO" is that it contains a detergent or cleaning ingredient which acts with the oil as soap does with water. It keeps the undesirable oxidation parti-

What Do YOU Look for in a Mechanical-drive Turbine?

LOW-COST BY-PRODUCT POWER?

You have it—24 hours a day, 7 days a week—when you use General Electric's Type D turbines, because they provide an economical drive for general-purpose apparatus and power-plant auxiliaries. Simultaneously, they supply low-pressure steam for process or seasonal heating. Unreclaimable losses are less than five per cent. Nozzles correctly proportioned, buckets contoured to approximate the steam expansion characteristics, low-loss packing glands—all to get more work from the energy in a pound of steam. And, where over-all plant economy is important, mechanical-drive turbines save again because of the low maintenance expense and small amount of attention required.

CLEAN STEAM FOR PROCESS?

Because no lubrication is required in the steam passages of a turbine, you can be sure of oil-free steam.

COMPLETE SAFETY?

In our improved Type D's you can be sure of *positive protection* against overspeed. If for any reason speed becomes excessive, an emergency trip device operates to instantly close a built-in combined trip and throttle valve that shuts off all steam flow. Here's complete safety available as a standard feature. Turbine drives can also be used safely in inflammable and explosive atmospheres.

LIFETIME DEPENDABILITY?

Without "time out" for maintenance or repairs, G-E turbines keep going to meet today's demands for continuous performance. They keep going even when adverse operating conditions exist, such as unusually high ambient temperatures or excessively moist atmospheres. And, in dual-drives, turbines either pick up the load instantly when called upon to do so or divide the load with the motor for the most economical heat balance.

FLEXIBILITY?

Because of their adaptability to any speeds within wide limits and the availability of reduction gear units, turbine drives permit operation of the driven equipment at its most efficient speed. Turbines built for one steam pressure can usually be adapted to another pressure by minor changes.

EASE OF SERVICING?

Take out one linkage pin, remove eight bolts, lift the valve bonnet—in less than two minutes you have completely exposed the inlet valve for inspection. Want to clean the steam strainer? There's no need to break the station piping or remove the governor valve in the improved Type D. Does the carbon packing need adjusting? Detachable boxes and garter springs make it easy. All pipe connections are made to the lower half so that the cover can be easily removed for inspection of internal parts.

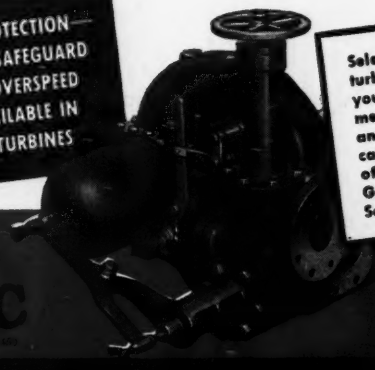
LOW INITIAL COST?

For what you would pay for an ordinary turbine, you can obtain a Type D with positive overspeed protection, improved bearing cooling, and built-in throttle valve. Remember, production line manufacturing, made possible by the widespread demand for this turbine, means more for your turbine dollar.

MINIMUM MAINTENANCE EXPENSE?

It's attention to details that builds reliability—and keeps maintenance costs low—in G-E turbines. Bucket and valve materials are carefully selected for resistance against corrosion and erosion; bearings are water-cooled to give low operating temperatures; packing glands are made of carbon for long life and infrequent attention.

POSITIVE PROTECTION—AN ADDED SAFEGUARD AGAINST OVERSPEED NOW AVAILABLE IN TYPE D TURBINES



Selection of the right turbine depends upon your specific requirements for process steam and power. Why not call our nearest G-E office for practical help? General Electric Co., Schenectady, New York

GENERAL ELECTRIC

★ SPECIFY-ERNST ★
LEAKLESS COCKS
HAVE YOUR BOILERS EQUIPPED WITH
"SPLIT-GLAND"
ADJUSTABLE WATER GAGES
FOR FLAT OR ROUND GLASSES
AT ALL TEMPERATURES AND PRESSURES
VERTICAL or INCLINED
MADE TO FIT ANY WATER COLUMN OR BOILER
FOR COMPLETE WATER COLUMN EQUIPMENT "Better C" ERNST
Split-gland shown open for replacement of flat-glass unit.
HOW IT WORKS
Split-gland shown closed for compression of packing gasket.
FOR CLEAR VISION USE ERNST PLAIN SIGHT ILLUMINATORS
SAFETY and SATISFACTION
SEND FOR CATALOG P2
Water Columns Forged Steel For All Pressures
Wire Glass "Better C" Guards
REFLEX "C-Black" Glass Inserts
High pressure and temperature Gage Glass Gaskets—"They Won't Blow Out."
ROUND - TUBULAR GLASSES for High Pressure Service — Clear or Red Line Magnifying.
CLEAR
REFLEX
COVER GASKET
PRESSURE GASKET
CLEAR & REFLEX GLASSES, all sizes
ERNST WATER COLUMN & GAGE CO., LIVINGSTON, N. J.
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cles circulating with the oil and prevents them from depositing in the engine, but they do not cut down lubricating qualities and, being in suspension, are easily drained out of the engine. This oil, it is claimed, both lubricates and cleans, thus making it unnecessary to take the engine out of service in order to get rid of deposits and sludge in the oiling system.

Pneumatic Belt Conveyor Roller

RECENT development in the materials handling field is the pneumatic roller, for carriers on belt conveyors, introduced by Stephens-Adamson Mfg. Co., Aurora, Ill. These pneumatic carriers are for use under loading spouts and in belt feeders where the impact of heavy bulk loads subject belt and carrier to abnormal strains. Rollers are made up of a series of pneumatic rubber units, 6 in. diameter, mounted on the steel hub in which bearings and shaft are housed. These units have thick, wear-resisting treads and are inflated and permanently sealed to prevent loss of air.

Bracket Type Resistors

OHMITE wire-wound vitreous-enameled resistors are available in Live Bracket and Dead Bracket types for special applications, from the Ohmite Mfg. Co., Chicago, Ill.

Live bracket type has flexible leads connected to tin-plated brass brackets, for making electrical connection by bolting the slotted brackets to panel terminals.

Dead bracket type is mounted by bolting to the brackets, electrical connections being made separately to the lugs. Resistors are mounted by through-bolts, the leakage distance from lug to bracket being regulated by mica washers or by locating the lugs as far in as required. Core sizes are available in a wide range of diameters from $\frac{5}{8}$ to $2\frac{1}{2}$ in.

Conveyor Belt for Coke Wharf Service

AN ENTIRELY new type conveyor belt, for specialized coke wharf service, is announced by The B. F. Goodrich Co., Akron, Ohio. The belt's construction provides a double thickness of cover over the areas of greatest wear on both the top and bottom of the belt, so that when abrasion wears this down the belt can be turned over and additional service be obtained from the untouched cover area.

Four full-width and 4 half-width plies of 32 oz. duck provide a total tensile strength equal to 6 full-width plies. The cover is made of a compound which provides exceptional resistance to aging as well as abrasion.

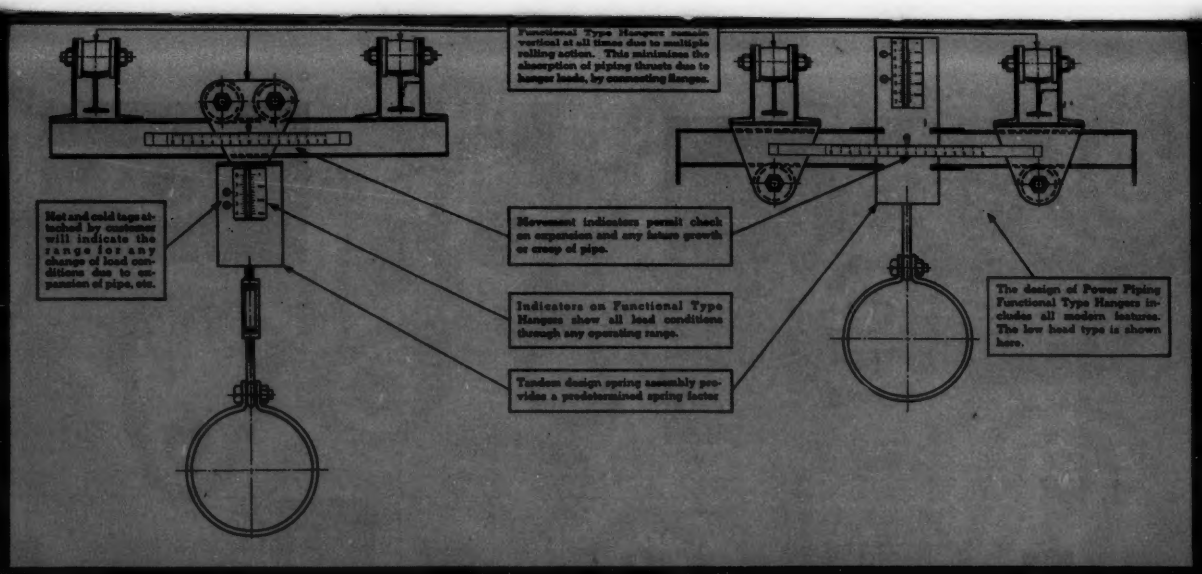
Cover thickness of the area of greatest wear on top and bottom of the belt is $\frac{1}{4}$ in. and $\frac{1}{8}$ in. over the remaining width.

New line of Spirakore-design, outdoor current transformers has been recently announced by the General Electric Co., having capacities of 25 and 34.5 kv.hr., embodying reduced weight, smaller dimensions, porcelain shells and Pyranol liquid filling. The 25-kv. is designated as KF-311 and the 34.5 kv. as KF-316.

For handling and stacking boxes and packages, Lewis-Shepard Sales Corp., Watertown, Mass., has developed a hand-operated truck. It can lift to car door height, has large floor wheels, is arranged for vertical frame to move on wheel base, so that load can be slid forward while base is stationary.

ABP

POWER PLANT ENGINEERING is proud of its membership in The Associated Business Paper, and of the publishing standards which help to make this magazine an accepted authority in the field of power generation, transmission and utilization.

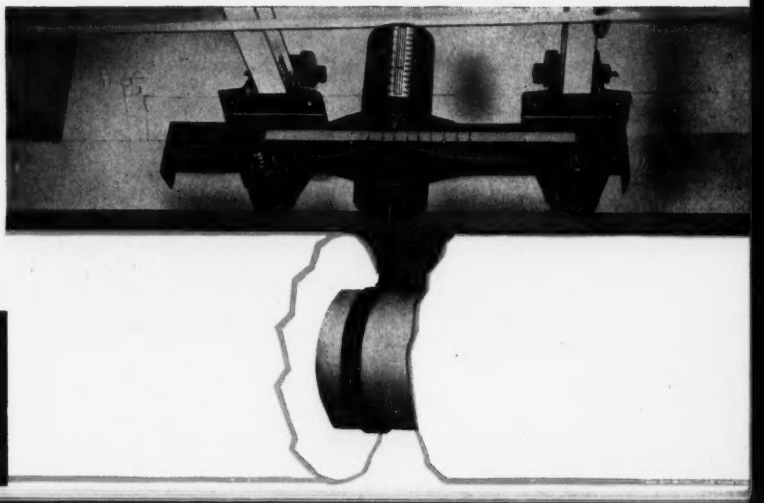

Functional Type Hangers remain vertical at all times due to multiple rolling action. This minimizes the absorption of piping thrusts due to hanger loads, by connecting flanges.
Hot and cold tags attached by customer will indicate the range for any change of load conditions due to expansion of pipe, etc.
Movement indicators permit check on expansion and any future growth or creep of pipe.
Indicators on Functional Type Hangers show all load conditions through any operating range.
Tandem design spring assembly provides a predetermined spring factor
The design of Power Piping Functional Type Hangers includes all modern features. The low head type is shown here.

TYPICAL LAYOUT OF THREE PLANE PIPING STRUCTURE SUPPORTED BY POWER PIPING FUNCTIONAL HANGERS AND VIBRATION ELIMINATORS

POWER PIPING FUNCTIONAL HANGERS *Supply the Need in Modern Piping Systems*

Power Piping Functional Type Spring Hangers are recommended for use on pipe lines subjected to temperature changes, vibration or shock occasioned by connection to rotating machinery, or pulsations caused by flow of steam or other fluids. These hangers allow lateral and longitudinal swinging movement within reasonable limits.

Send for illustrated bulletin giving types, sizes and detailed characteristics of Power Piping Functional Type Hangers and Vibration Eliminators.



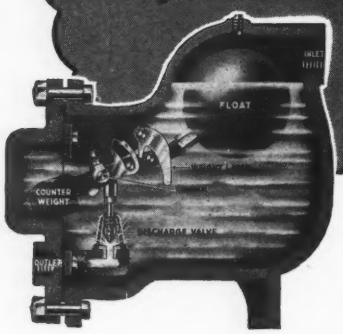
BLAW-KNOX COMPANY
POWER PIPING DIVISION
1525 Pennsylvania Ave., Pittsburgh, Pa.

Will hold tight in Tough Service

NICHOLSON

Weight Operated

TRAPS



For Steam Pressures up to 1500 lb. with Superheat

For Air and Gasoline Pressures up to 1500 lb.

YOU'LL find these Nicholson Weight-Operated traps particularly suitable for draining condensate from all types of equipment utilizing, storing or conditioning steam, air, gas or gasoline—such as Steam Separators, Line Purifiers, Water Legs, Dry Kilns, Water Heaters, Pipe Coils, Air Separators and Tanks, Gasoline Accumulators, etc. They are widely used also for draining steam and air lines carrying pulsating pressure caused by reciprocating engines, pumps or compressors.

Nicholson Weight-Operated Traps have cast steel construction for steam pressures up to 1500 lb. with superheat, and air and gasoline pressures up to 1500 lb. They have cast iron construction for steam pressures to 225 lb, air and gasoline pressures to 250 lb. These Nicholson traps give an excellent account of themselves in superheated steam service. Body can be absolutely dry, due to re-evaporation but valve will hold tight and leak no steam.

Write today for your copy of new Catalog No. 240. It describes the full line of Nicholson Traps for all service, including Industrial Steam Traps, contains recommended piping diagrams and other useful data.

Also Nicholson—

Welded Floats, Industrial Steam Traps, Control Valves, Flexible Couplings, Steam Eliminators and Separators, Compressed Air Traps

W. H. NICHOLSON & COMPANY
160 OREGON ST. WILKES-BARRE, PA.

Today's Fight

For Success

• •

To engineers, managers and stockholders of any manufacturing plant or service establishment, the power plant equipment makes up the weapons in today's battle for continuous and successful operation. In a large measure, it controls improvements, economies, dividends.

To gain success and move forward with the great power plant industry calls for a broadened knowledge on the part of operating engineers and managers in the value of the modern methods and equipment as described in the advertisements of this and other issues of POWER PLANT ENGINEERING.

MANUFACTURERS' PERSONALS

Cutler-Hammer Transfers A. M. Wolf

A. M. WOLF has been transferred to the St. Louis office of Cutler-Hammer, Inc., as announced recently by G. E. Booth, manager of the company's St. Louis sales territory. Increased demand for C-H Equipment has made necessary this addition to his force.

A. M. Wolf

Graduated from Armour Institute of Technology, Mr. Wolf was employed by the Public Service Co. of Northern Illinois in the Sub-Station Construction Department before joining the Cutler-Hammer organization in the Experimental Department. He was well grounded on design and operation of C-H equipment when he started his sales career in the Detroit office.

Crane Co. Elects New President

JOHN H. COLLIER was elected president of Crane Co. by its Board of Directors at a special meeting held on May 5. He will fill the vacancy created by the sudden death of Charles B. Nolte on April 29.

J. H. Collier

Mr. Collier was born in Chicago in 1884, was educated at Purdue University, and joined Crane Co. on leaving school in 1903. From his original position as core maker's helper 38 yr. ago he has progressed through a variety of positions giving him a very intimate and thorough grasp of the company's activities. He

There's more to POWELL QUALITY than meets the BUYER'S EYE!

DID YOU EVER CONSIDER THE FINAL STEPS, IN THE MANUFACTURE OF A LARGE VALVE? It's a Major Operation . . . and it's treated as one at Powell!

A large steel or alloy valve coming from the foundry represents countless hours of research, design and casting technique . . . but it still lacks the final machining and testing that will turn it into an efficient product that will be well worth its purchase price. Undoubtedly, then, these two final operations are of vital importance . . . it's a major part of any valve's manufacture, and Powell, accordingly, stresses these two phases.

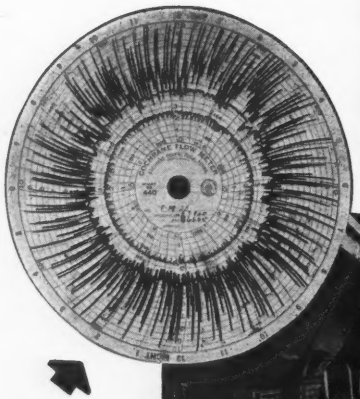
Take, for instance, the machine shop. Modern tools in the hands of skilled operators assure accurate fitting of parts . . . constant inspection and accurate gauging of parts insures proper fit in assembly . . . guarantees a pressure tight valve. Then, testing. Here's the proof of the pudding. Each valve is tested under pressures far exceeding its rated capacity. Each moving part is seen to work exactly as it should. Each completely assembled valve is again rechecked and inspected . . . then, and only then, is it approved for shipment . . . guaranteed for use on large lines that can't be burdened with inefficient valves.

So, in summing up the important operations that go into the building of a large valve, it can be seen that machining and testing stand near the top . . . that they are very necessary in assuring "quality, through and through"—a phrase truly applicable to every Powell product.

You Need More Than a Photograph of the Finished Product to See ALL of the Qualities that Make Powell Valves Uniquely Able to Better Serve the Power Engineer

POWELL VALVES

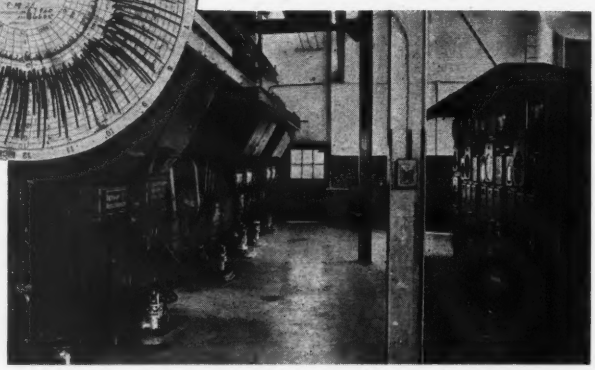
THE WM. POWELL COMPANY • CINCINNATI, OHIO



Flow meter chart above shows abrupt load swings—note how the steam pressure remains close to 125 lbs.

HANDLES *automatically* LOAD SWINGS OF FROM 8,000 to 25,000 lbs. OF STEAM PER HOUR...

For Rubber Goods Manufacturer



THIS Company manufactures extruded and molded rubber products such as automobile floor mats, steam is used chiefly in curing vats, vulcanizers, molding machines and for space heating. Steam is introduced intermittently to the curing vats, consequently the process load is extremely variable as shown by the chart. *Six to ten times an hour the load jumps abruptly from 8000 to as high as 25,000 lbs. an hour* from each boiler. Yet in spite of this tremendous fluctuation Hays Automatic Combustion Control allows the steam supply to follow the demand faithfully with an average boiler efficiency of 82%. Evaporation has been raised from 8 lbs. in the old plant to 11 lbs. or better and the cost per 1000 lbs. of steam has been reduced from 27 cents to approximately 20 cents. CO_2 is maintained practically constant at around 13%.

This case is typical of what Hays Centralized Automatic Combustion Control is doing in hundreds of steam generating plants of all sizes, burning all types of fuel. Let us tell you what automatic control can do for your own plant.

For the complete story of this interesting application of automatic combustion control send for publication No. 40-396—its free.

NOTE TO ENGINEERS

Tear off the bottom of this ad and send with your name and address to The Hays Corporation and we will send you copy of "Automatic Combustion Control and Its Relation to Lower Steam Costs".

The HAYS CORPORATION

SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL

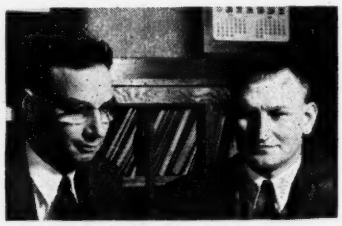
MICHIGAN CITY, INDIANA, U.S.A.

held the positions of General Manager, Bridgeport, Conn., plant, Crane Co. from 1917 to 1929; was President, Cie Crane, Paris, France, and Chairman, Crane, Ltd., London England, from 1929 to 1933; and has been Vice President in Charge of Manufacturing, Crane Co., Chicago, from 1933 to 1941.

Being in hearty accord with present Company policies which he considers sound and well established with the organization at a high peak of efficiency, he intends to continue the policies which have been in effect.

Bush and Sealey Promoted by A-C

FRED W. BUSH and W. C. Sealey have recently been promoted to key positions in Allis-Chalmers transformer division, with headquarters in Milwaukee, succeeding L. H. Hill, recently appointed assistant manager of the company's electrical department. Mr. Bush has been made engineer-in-charge of transformer sales and Mr. Sealey, engineer-in-charge of transformer design.



Fred W. Bush **W. C. Sealey**

Mr. Bush, a graduate of Georgia Tech, joined Allis-Chalmers in 1928 and has been connected with transformer engineering, development and sales since 1930. Mr. Sealey, a graduate of Carnegie Tech, joined the Allis-Chalmers Transformer Division in 1931 when the company absorbed the American Brown Boveri interests, and prior to 1928 was connected for several years with the transformer division of Westinghouse.

Messrs. Bush and Sealey both are actively identified with the American Institute of Electrical Engineers, and have contributed papers and articles of value to engineering publications on transformers and feeder voltage regulators. Mr. Sealey has a number of patents to his credit.

William H. Pratt Retires

IN RECOGNITION of his service to the electric meter industry, William H. Pratt, retired after 45 yr. with General Electric Co. Works at Lynn, has received the first New England Award to a living engineer resident in New England for outstanding achievement. Graduating from Massachusetts Institute of Technology in 1894, he obtained his first patent for a watthour meter in 1897 and has acquired 76 patents, largely on fundamentals and improvements for electric measuring instruments, but including hollow article construction and an internal combustion engine. The award was made for a committee of Engineering Societies of New England, Inc., by Holcombe Brown, its president.

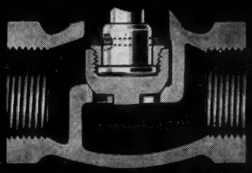
A Plus Service For Engineers

Backing up their regular advertisements in POWER PLANT ENGINEERING, many manufacturers have prepared special catalogs and bulletins describing in greater detail the construction, installation and operation of their equipment. This literature is up-to-the-minute and frequently contains engineering data not available elsewhere.

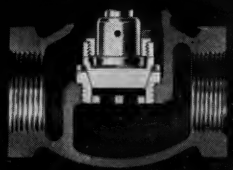
Should you desire a catalog or specific information regarding power plant equipment, we will gladly get it for you from the manufacturer. Let us know also if you are interested in any particular piece of equipment, such as a pump, compressor, motor, fan, superheater, and we will get useful data for you on the different makes. Just write our Reader Service Department.

WE BELIEVE YOU WILL ANSWER "YES!"

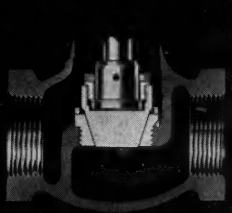
to these 3 Questions about Your Bronze Globe and Angle Valves



BRONZE REGRINDING GLOBE VALVES



BRONZE SEMI-PLUG GLOBE VALVES



BRONZE FULL PLUG GLOBE VALVES

1 Would it help solve some of your valve troubles if stems of Bronze Globe and Angle Valves were stronger—processed to give exceptional resistance to corrosion—made of naval bronze for great resistance to galling, seizing and wear?

2 Would it cut your cost of valve maintenance if seats and discs were harder? Do you want greatest resistance to galling and seizing, as well as to damage by foreign matter in the line?

3 Would it make it easier for you to select valves if you could find these and other matching qualities in *one family* of Bronze Globe and Angle Valves—in one family that includes valves designed for each *type* of service—150 lbs. to 350 lbs.?

You will find what you want, then, in Pratt & Cady Bronze Globe and Angle Valves—*now, in every detail of design and materials in line with the great needs of today*. Write for details of this great line of Bronze Globe and Angle Valves.

•

FOR GENERAL SHUT-OFF SERVICE—Or for occasional throttling air, hot water and saturated steam. Pratt & Cady Regrinding Valves. Ratings, steam: 125 lbs., 200 lbs., 250 lbs., 300 lbs. Screwed and flanged ends.

FREQUENT THROTTLING—Also for bleeder connections, boiler feed line, railroad, marine, oil refinery and other services where ordinary valves wear out quickly. Pratt & Cady 300 Brinell Semi-plug type Globe Valve. Ratings, steam: 200 lbs. and 300 lbs. Screwed and flanged ends.

SEVERE THROTTLING—At maximum rated pressures and temperatures. Exceptionally wide seating contact. Seats and discs of extreme hardness to resist damage by grit in the line—heat treated to prevent galling. Pratt & Cady 300 and 500 Brinell Full plug Globe Valves. Ratings, steam: 150 lbs., 250 lbs., 300 lbs. and 350 lbs. Screwed and flanged ends.

R READING
CAST STEEL VALVES & FITTINGS

PC PRATT & CADY
BRASS & IRON VALVES

D'ESTE
VALVE AND ENGINEERING SPECIALTIES

READING-PRATT & CADY

READING, PENNSYLVANIA

A Division of AMERICAN CHAIN & CABLE COMPANY, INC.

'Self-starter and Brake'

SAVE TIME and LABOR in Cleaning Tubes with the New ROTO

Model 130 air-driven motor with swing-frame head and air valve for one-man operation.

Tube cleaners, like automobiles, perform best when controlled entirely by one man. That's why the new, powerful Roto Cleaner, equipped with an operating air valve is setting new performance records in power plants throughout the country. With it, the operator himself can start and stop the cleaner instantly, eliminating the need for a helper and avoiding delays due to signalling.

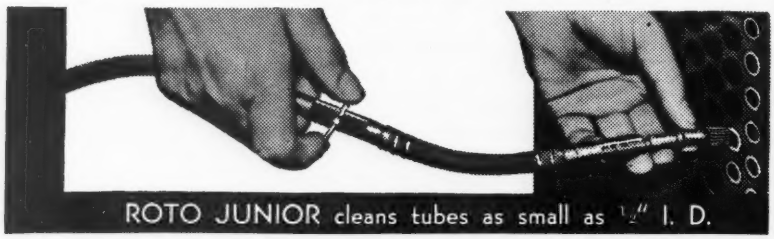
The Roto Air Valve pays for itself many times over. It can be attached to any make cleaner, but with the powerful new Roto Tube Cleaner, you get the utmost in performance and economy.

Write for full details today.

SEE OUR ADV. IN SWEET'S AND WRITE

The ROTO Company

145 Sussex Avenue, Newark, N. J.



ROTO JUNIOR cleans tubes as small as ½" I. D.

More for Your Money

Because advertising is so widely used in the United States, we are the best informed people in the world on what there is to buy, what it will do for us and where to buy it. Because advertising is one of the most economical parts of the selling process and helps identify power plant products of known performance value, it is an important aid in getting more for your money.

Mr. Pratt has been active in standards and industrial work, serving in 1930 as American representative at the International Electrical Congress in Scandinavia and in preparing the National Meter Code of the Committee of American Standards.

Roller-Smith Promotes Swoish and Bevan

APPOINTMENT of W. R. Swoish, in charge of sales, and James E. Bevan, in charge of manufacturing, as Vice Presidents of Roller-Smith Co., was recently announced by J. D. Wood, President.

W. R. Swoish

J. E. Bevan

Mr. Swoish, graduating from Ohio State University in 1921, went with Westinghouse Elec. & Mfg. Co. in switchgear sales, then as sales manager of distribution transformers and later of circuit breakers and switchgear and in 1939 came to Roller-Smith.

Mr. Bevan, a graduate of Lehigh University in 1925, was with Bethlehem Steel Co. and with Philadelphia Electric Co. before he joined Roller-Smith Co. in 1940.

Ralph Hoffman Elected Link-Belt Vice President

Alfred Kauffmann

ALFRED KAUFFMANN, Link-Belt Company president, announces that with a view to making the general office organization a more effective aid to plant sales managers, the board of directors has elected Ralph M. Hoffman a vice-president, delegating to him the general direction and supervision of sales for the company.

Mr. Hoffman, a mechanical engineer, University of Minnesota, 1911, has been assistant to the president since January, 1940, with headquarters in Chicago, where he will continue to have his office.

He came to the Link-Belt organization in 1923 as manager of Link-Belt Meese & Gottfried Co.'s Seattle branch. He served in this capacity until 1931, the name of the Pacific Coast subsidiary meanwhile becoming Link-Belt Company Pacific Division; and from 1931 to 1939 served as vice-president and sales manager of this subsidiary, with headquarters at San Francisco.

Armstrong Cork Co. announces expansion of the advertising department to include all promotional activity, and the appointment of M. J. Warnock as Director and E. Cameron Hawley as Assistant Director of Advertising and Promotion.

These PRECISION QUARTER-MARKS *make* WeldELLS WORTH MORE

IN developing WeldELLS we gave a lot of consideration to the common-sense principle that the *easier* it is to handle a job, the *better* it will be handled. The precision quarter-marks at each end of every WeldELL are one of many examples of this.

There are many times when these convenient reference marks save a lot of troublesome figuring—help eliminate errors—make it easier to turn out a perfect job. At such times this feature alone would justify your selecting WeldELLS. But you also have the seven other sound reasons listed opposite.

Of course it costs us something to provide these betterments that are combined only in WeldELLS, but giving you this added value is only in keeping with principles that Taylor Forge has observed for more than 40 years: First, *sound engineering design—then maximum utility, convenience, and economy.*

Some of these features cut installation costs. Others add to the value of the finished job . . . Yet WeldELLS cost no more.

Write for Taylor Forge Catalog 401. It contains not only complete information on Welding Fittings and Forged Steel Flanges, but also a lot of useful engineering data.

TAYLOR FORGE & PIPE WORKS, General Office & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Building

Taylor Forge

WeldELLS

Seamless Pipe Fittings for Welding

OTHER EXTRA-VALUE FEATURES

You can't ask for a single thing in welding fittings that WeldELLS do not have. No other fittings for pipe welding combine these eight features. In addition to quarter-markings (described opposite) the features are:

1. Seamless — greater strength and uniformity.

2. Tangents—keep weld away from zone of highest stress—simplify lining up.

3. Selective reinforcement—provides uniform strength.

4. Permanent and complete identification marking†—saves time and eliminates errors in shop and fields.

5. Wall thickness never less than specification minimum—assures full strength and long life.

6. Machine tool beveled ends—provides best welding surface and accurate bevel and land.

7. The most complete line of Welding Fittings and Forged Steel Flanges in the World—insures complete and undivided responsibility.

†Since the marking is pressed into the metal before forming, and since the manufacture of the fittings is carried out at a forging temperature, each in effect receives a heat treatment after the operation. The indentations have no sharp corners or edges and the marking has no effect on the strength of the fitting.

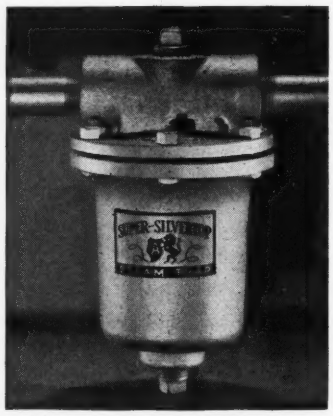
IT'S SO EASY TO INSPECT
THAT GUIDED BUCKET IS GOOD ENGINEERING
THAT SIMPLIFIED PIPING SAVES MONEY
STRAIGHT THROUGH PIPING MAKES A GOOD LOOKING INSTALLATION

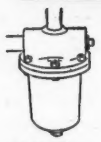
These features are extremely popular... that's why others must follow SUPER-SILVERTOP

♦ Straight-line piping of inverted bucket traps is so sensible, logical, economical and popular that we predict others *must* follow the lead of Anderson Super-Silvertop.

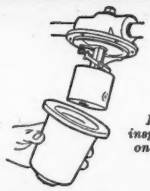
But there are other popular, important features to Super-Silvertop—the modern, engineered inverted bucket trap. There's the simplified piping of Super-Silvertop used as an elbow (no extra fittings needed). Also the ease of inspection without taking trap off the line. Then there is the extra capacity due to a larger, guided bucket (which can open a larger valve). And of course the advantage of "snap action" heat when Super-Silvertops are equipped with "snap action" Thermal Air Eliminators.

Besides *these* reasons why users specify Super-Silvertop, there are others—all described fully in the book "How To Choose A Steam Trap" which will help you on your drainage and condensation problems even if you have other makes of steam traps. Ask us for your copy—it's worth having and free, so why not write today.





As an elbow-- no extra fittings needed.



Easy to inspect right on the line.

THE V. D. ANDERSON CO.
1939 W. 96th Street • Cleveland, Ohio

Super-Silvertop
STEAM TRAPS

Change of Address

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

Mr. Warnock joined the Armstrong organization in 1926, spending the following 3½ yr. in the Seattle district as salesman and later as District Manager. Early this year he was made Assistant General Sales Manager, succeeding, in his new position, John P. Young, who has resigned.

Mr. Hawley joined the Armstrong organization in 1927 as a member of the Advertising Department, was later Assistant Sales Manager of the Corkwood Division, Director of Commercial Research, and since 1936 has been Director of the Bureau of Retail Merchandising for the Floor Division.

American Society of Tool Engineers

AT THE RECENT annual meeting of the board of directors of the American Society of Tool Engineers, Detroit, Mich., Frank W. Curtis, Chief Engineer of the Milling Machine Division of Van Norman Machine Co., Springfield, Mass., was elected president. Other officers include: Otto W. Winter, Factory Manager, Columbus McKinnon Chain Corp., Tonawanda, N. Y., first vice president; Ray H. Morris, vice president, Hardinge Bros., Hartford, Conn., second vice president; Clyde L. Hause, Sales Engineer, Gorham Tool Co., Detroit, secretary, and Frank R. Crone, Chief Tool Designer, Lincoln Motor Co., Detroit, treasurer. Mr. Curtis recently announced that dues will be waived for members inducted into service.

Of recent weeks, four new chapters have been granted charters; Seattle, Wash., is Chapter No. 39; Springfield, Vt., Chapter No. 40; New Haven, Conn., Chapter No. 41; and Hamilton, Ontario, is Chapter No. 42. Since January, 1940, membership has increased 73 per cent and is expected to pass the 7000 mark this spring.

Norman R. Gibson

DR. NORMAN R. GIBSON, a vice president of Niagara Hudson Power Corp., was elected a director of the corporation at the recent annual meeting. He is Chief Engineer of the Niagara Hudson companies. Starting with the Hydraulic Power Co. of Niagara Falls as a hydraulic engineer in 1918, Dr. Gibson was later made executive engineer of the Niagara Falls Power Co. and in 1926 was elected vice president and chief engineer of the Niagara Falls Power Co. In 1929 he became vice president of Buffalo, Niagara and Eastern Power Corp. and has been a vice president of Niagara Hudson Corp. since 1931. His service with the Niagara Hudson companies has thus been continuous for 23 yr.

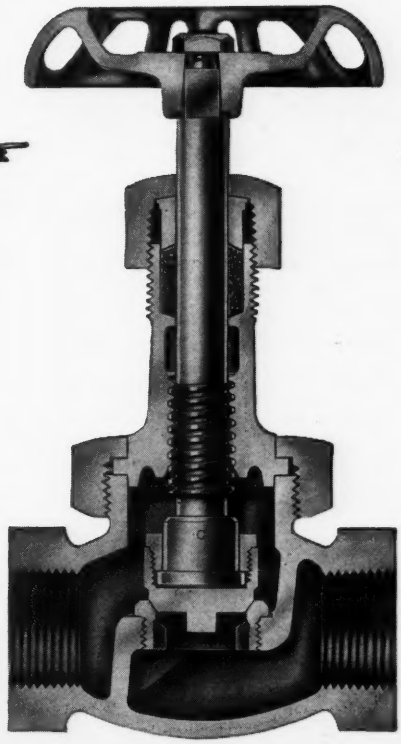
He holds an honorary degree of Doctor of Engineering from the University of Toronto, and was awarded the Elliott Cresson Gold Medal in 1930 by the Franklin Institute of Pennsylvania for his invention of The Gibson Method and Apparatus for Measuring the Flow of Liquids in Closed Conduits.

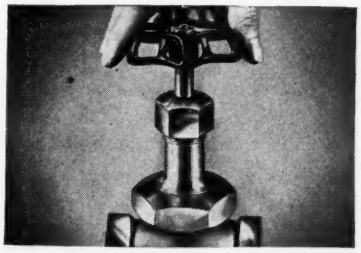
Dr. Gibson is a member of the American Society of Civil Engineers, the Engineering Institute of Canada, American Society of Mechanical Engineers, and a Fellow of the Royal Society of Arts. His home is in Lewiston Heights, Niagara Falls, N. Y.

Yes..there is a difference

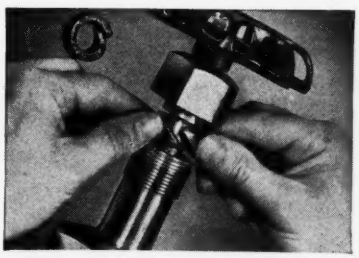
in regrinding valves!

Check over the extra convenience and service features you get in this Bevel Seat type Regrind-Renew Valve— JENKINS FIG. 970

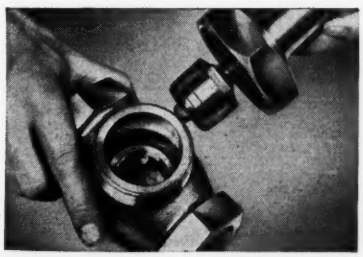




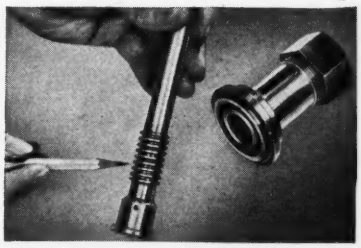
1 Start with the perfect grip, non-heat handwheel. The ingenious deep scallop design affords a firm grip even for greasy hands. Trimming of this valve is interchangeable in globe or angle bodies, screwed or flanged.



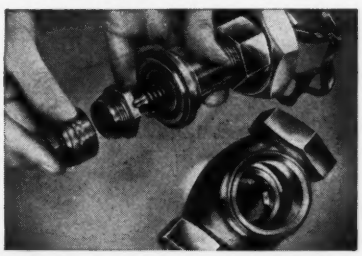
2 Notice how easily the valve can be repacked. Loosen the hexagonal packing nut, slide the packing gland up and new high pressure asbestos packing can be readily inserted.



3 Bonnet and trimming are removed simply by loosening the husky union bonnet ring. Spindle has a hole drilled for pin insertion to simplify regrinding operation, with the spindle serving as a regrinding tool.



4 Look at those perfectly machined spindle threads that afford full engagement with the bonnet. Also the beveled shoulder that seats firmly in champered surface of the bonnet to permit repacking under full pressure.



5 See how easily the nickel alloy disc can be renewed. It screws over the disc lock nut and is held securely by a lock-washer with bent-over flanges. Beveled seating surfaces of the disc and renewable nickel alloy seat ring remain constant no matter how often they are reground.

Here is a valve that welcomes your most critical examination. In these illustrations we practically turn it inside out to show you how it is especially suitable for severe services where tightness is essential and operation is frequent.

Study the section view for example. Notice the extra heavy spindle with perfectly machined threads of correct pitch and lead to insure tight closure with least closing effort. The bevel face of the seat ring parallels and equals that of the disc. There is no overhang; disc will not have shoulders or grooves cut in it when regrinding. Also, the disc is self-adjusted to the seat by the crowned spindle end.

From wheel nut to Jenkins specially wear-resistant nickel alloy seat, you will find perfection of design and workmanship in every detail of Fig. 970. It is available in a wide range of sizes; globe or angle, screwed or flanged—for steam services up to 300 lb.; 600 lb. non-shock cold oil, water, gas. You can obtain prompt delivery from stock at reliable supply houses everywhere.

JENKINS BROS., BRIDGEPORT, CONN.

LOOK TO Jenkins FOR THE BEST IN VALVE DESIGN

Answers Your
"INFORMATION PLEASE"
on
FLOW OF ALL FLUIDS

HUNDREDS of power plants now rely on Simplex Meters to give them the dependable rate-of-flow data so necessary in checking up operating costs.

Simplex Meters answer quickly and accurately your requests for "Information Please" on totalizations of Boiler Feed, Turbine Condensate, Steam, Air or other fluids.

There is a Simplex Meter to suit your specific measuring problems. Let our engineers show you how the proper selection of modern metering equipment can insure better plant control and worth while savings in operating expense. Write for descriptive Bulletin No. 52.

SIMPLEX VALVE & METER CO., 6790 Upland St., Philadelphia, Pa.

SIMPLEX METERS

WE READ WATER

Every drop of water and every drop of brine has a story to tell us. We know how to read it and answer the many difficulties it is bringing your plant. The story tells a battle against efficiency in your plant . . . corrosion, scaling, living organisms, too much of this chemical, too little of that. We read it, tell the answer, and have the organic chemicals to correct the water and the brine. Known throughout the Nation are these Haering products . . .

Chrom Glucosates
For Corrosion Prevention

Sodium Glucosate
For pH Adjustment

Sulpho Glucosates
For Oxygen Removal

Quachrom Glucosate
For Corrosion Control

Beta Glucoside
For Scale Prevention

H-O-H Feeders
For Accurate Proportioning

Pyro Glucosate
For High Pressure Boilers

In-Hib-Co Coatings
Protect tanks, pipes and all exposed surfaces.

Our laboratories in Chicago, Wichita, Kansas, and New York City serve you overnight. Send us your water problems; or write for our house organ, "H-O-H LIGHTHOUSE."

D. W. HAERING & CO., Inc.
Water and Brine Consultants
2308 S. Winchester Ave., Chicago

W. H. Bixby, president of W. H. Bixby, Inc., of Des Moines, has announced the addition of R. C. Adams to the organization. Mr. Adams will be actively engaged in sales engineering work, handling the well known products of Cochrane Corp., Bartlett-Snow, Diamond Power Specialty, Hays Corp., Detroit Stoker Co., and A. P. Green Fire Brick Co.

Stephen B. Haynes has been elected assistant treasurer of the Cochrane Corp., Philadelphia manufacturer of power plant equipment. Mr. Haynes graduated from Yale University in 1924 and has had a wide experience in financial and accounting matters. He had previously been associated with the Mathieson Alkali Works, Inc., in a sales promotional capacity and the Associated Drygoods Corp. in financial work.

Philadelphia office of the Pangborn Corp. is now located at 901 Beury Bldg., 3701 N. Broad St., with Forrest G. Sharpe as Philadelphia Sales Engineer. Mr. Sharpe has had 16 yr. experience in the Hagerstown district handling blast cleaning and dust control problems.

Offices, research and analytical laboratories and consulting rooms of W. H. & L. D. Betz have been removed to enlarged quarters at Gillingham and Worth Sts., Philadelphia, Pa., made necessary by a 20 per cent increase of business during the last 3 yr., which is continuing in 1941. Increase in floor space is 400 per cent to accommodate the business and to step up efficiency.

James K. O'Brien has recently been appointed Assistant General Manager, direction of research continuing under Dr. H. Lewis Kahler.

American K.A.T. Corp. announces opening of a Philadelphia office in Commercial Trust Bldg., 15th and Market Sts., with Frank Campbell Coe in charge.

Roy S. Laird has been recently appointed Sales Manager for the Ohmite Mfg. Co. He has been with the Company 5 yr. on resistors, rheostats, chokes and tap switches.

Emmett O. MacDonald, for 54 yr. in the water works field, and manager at Sterling, Ill., for 15 yr., has retired at 76 yr. of age to travel and look over his former haunts. These cover Illinois, Iowa, Indiana, Michigan, Wisconsin, Ohio, Alabama, No. Carolina and Massachusetts.

J. C. Moomau, for 30 yr. with the water company in Champaign-Urbana, becomes manager at Sterling.

B. J. Brugge is now welding consultant and engineer at Washington, D. C., on application of arc welding in the National Defense Program. He will be associated with T. A. Canty, Inc., Lincoln Electric Co. representative in Baltimore, Maryland.

Changes in the engineering organization of John Morrell & Co., Ottumwa, Ia., are appointment of Elwood Johnson of Topeka plant to succeed Birnard E. Winger (resigned) as master mechanic at Ottumwa and promotion of Ross Kluckhohn of Ottumwa to master mechanic at Topeka. Mr. Johnson, a graduate of University of Minnesota, has been with the Morrell Co.

8 reasons for specifying
TUBE-TURN
Welding
TEE
Note in the illustrations here how the reinforcement is placed at all points of higher-than-normal stress. Numerous bursting-pressure tests prove that TUBE-TURN Tees will withstand higher pressures than pipe of corresponding size.
Write for valuable data book and catalog giving complete details on this new Tee and other TUBE-TURN Seamless Welding Fittings.
1
2
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6
7
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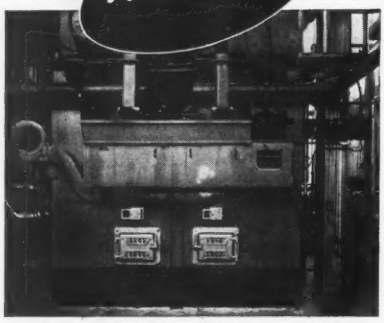
O SCH 40
TUBE
TURNS
280 WALL
1 Extra thickness at crotch reinforces where highest stress occurs.
2 Reinforcement along top of run adds needed extra strength here.
3 Reinforcement on sides—also a point of high stress gradually tapers toward end of outlet and bottom of run.
4 Longer outlet permits faster lining up and ample room for rod manipulation.
5 Ends machined to exact pipe wall thickness—easy to align and weld.
6 Increased thickness at bottom adds to full strength without excess weight.
7 Smooth inside walls, curved inner crotch and special manufacturing process assure even flow.
8 Size, material, thickness and name identified on permanent name-plate.
TUBE-TURNS
The original welding fittings—and still the best
Chicago Philadelphia

This FYR-FEEDER was paid for in less than A YEAR!



THE high return paid by the first FYR-FEEDER installation in a prominent eastern plant was actually almost unbelievable. In addition to using lower priced fuel, the unit reduced maintenance costs, supervision costs and auxiliary power costs. The total savings were sufficient for the FYR-FEEDER to pay off its cost and buy the second unit shown above — ALL IN LESS THAN A YEAR!

FYR-FEEDER installations that will pay for themselves in one, two, or three years time are known to be possible for hundreds of American plants today. Ability to deliver such a high return is the result of *(1) Low Initial Cost, (2) Easy Installation, (3) Low Operating Cost, (4) Freedom from Expensive Maintenance, (5) Excellent Combustion with Cheapest Coal.* Let us give you an engineering estimate of savings possible in your plant. Write, or use coupon below.

You Can See the Superiority
AIR FROM NOZZLES:
1. SPREADS COAL
2. PROVIDES AIR FOR COMBUSTION
3. CREATES TURBULENCE IN COMBUSTION CHAMBER
MULTIPLE SCREW FEEDERS 12" APART
TWO FIRES. FINES BURN IN SUSPENSION. LARGER COAL ON GRATE.
COAL
AIR IN TO INDIVIDUAL BURNERS
UNDER GRATE AIR

AMERICAN COAL BURNER COMPANY

FOUNDED 1918
Builders of Thousands of Overfeed Stokers

AMERICAN COAL BURNER CO.,
153 E. Superior St., Chicago, Ill.

☐ **YES. I want to know what the FYR-FEEDER can do in our plant.**

☐ **Please mail descriptive literature.**

Name_____

Street_____

Town_____

since 1930 and Mr. Kluckhohn, graduate of Iowa State College in 1930, was with Public Service Co. of No. Ill. and Moulding-Brownell prior to joining the Morrell Co. in 1938. He was president of Ottumwa chapter National Assn. of Power Engineers last year and is now treasurer.

Division of Power has been created in the office of the Secretary of the Interior with Abe Fortas as Acting Director, to cover power matters in the Department including reclamation projects, Boulder, Bonneville and Grand Coulee Dams and Indian reservation power.

Cincinnati Rubber Mfg. Co., Cincinnati, Ohio, announces the appointment of John Flocker & Co., Pittsburgh, Pa., as distributors of its line of industrial rubber products for Pittsburgh and surrounding counties.

William L. Batt, former president of A.S.M.E. and now deputy director of Production Division, O.P.M., has been awarded the 1940 Henry L. Gantt gold medal for distinguished leadership in the art and philosophy of industrial management.

Manning, Maxwell & Moore, Inc., of Bridgeport, Connecticut, announces that Leo W. Dillon has joined the organization to cover the Kansas City territory. Herman M. Munson will work in the Chicago district. Frederick W. Chadwick, formerly with Burns Brothers, Inc., of Syracuse, N. Y., will make his headquarters at Syracuse, to cover central New York and northern Pennsylvania.

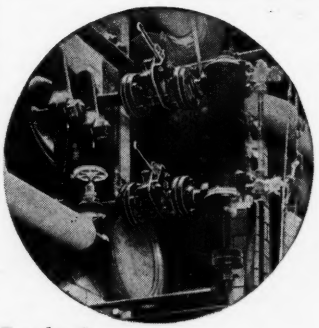
Harry T. Porter Co. is now sales agent in the Cincinnati district at Union Central Building, for Union Iron Works of Erie, Pa. For Western New York and Buffalo territory, the agent is now George G. Van Tuyl.

Edwin H. Price, Los Angeles representative of Manning, Maxwell & Moore, Inc., a member of the volunteer Naval Reserve, was called as of March 31 to serve in the capacity of Assistant Supervisor of Shipbuilding at the Union Iron Works plant of the Bethlehem Shipbuilding Corp. at San Francisco.

Aluminate Chemicals Ltd., representatives of the National Aluminate Corp. in Canada, has moved from 372 Bay St. to 555 Eastern Avenue, Toronto, Ontario.

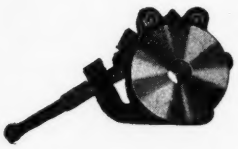
Meter Division of the Central Station Department of the General Electric Co. has moved to West Lynn, Mass., where most of the products, such as watthour meters, demand meters, instruments, time switches, and dry type instrument transformers, are manufactured. F. G. Vaughen, Manager of the Meter Division, will have an office at Schenectady as well as West Lynn. All others connected with the Division will be located at 40 Federal Street, West Lynn, Mass.

Cutler-Hammer, Inc., announces establishment of a warehouse at 131 Clarendon Street, Boston, Mass., which will carry a complete stock of the company's products. It is also announced that the company's Boston sales office



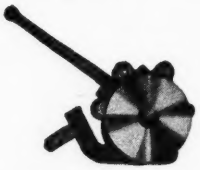
Everlasting Water Column Valve

For Safety at the Water Gauge



When Open....

the Everlasting Water Column Valve provides a straight through unimpeded passageway. The fact that the valve is open is visible at a glance, and a lock on the open indicator prevents accidental closing.



When Shut....

the record of the Everlasting Valve assures the operator of a leak-tight closure so that a new gauge glass can be installed without the necessity for protection of the operator's face and hands from escaping steam or water.

For pressures 250-lb. and less, made of bronze composition. Supplied in sizes 1¼-in. and 1½-in., screwed and flanged. For pressures above 250-lb. and up to 600-lb. made of cast steel with discs and seat faces of special alloy. Supplied in 1½-in. size with flanged ends.

Everlasting Valve Company

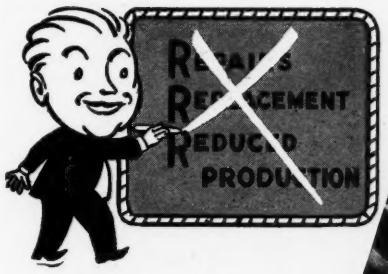
Jersey City, N. J.

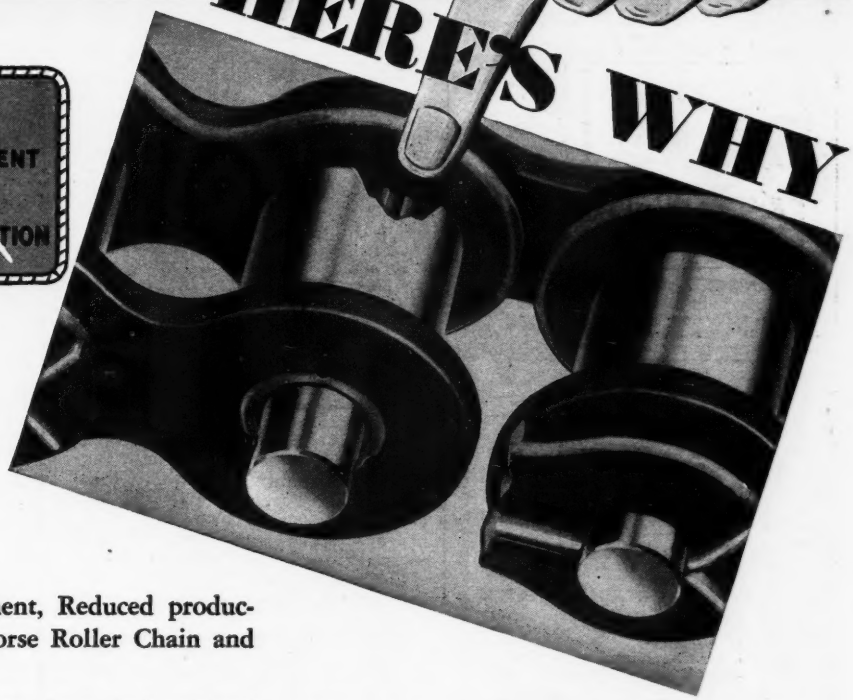
Everlasting Valves

for everlasting protection

Forget the three "Rs" . . .

Specify MORSE ROLLER CHAIN





HERE'S WHY

REPAIRS, Replacement, Reduced production! Install Morse Roller Chain and forget 'em!

For here's a roller chain that's designed and built to save you money, trouble, and time. It's a *better* roller chain, with years longer trouble-free service at high efficiencies.

Look at the positive lubrication system that's built in every link. Oil gets to the heart of the chain, wear stays out. Pins and bushings turn on a life-preserving film of oil, fed through the channels in the bushings.

The very finest materials—special alloy steels heat-treated to fit the demands of each part of the chain—and expert workmanship go into the manufacture of this chain. Its design is unique, but it is completely interchangeable with all other standard round pin roller chains.

Morse Roller Chain—with "force feed" lubrication in every link—is available in all sizes, and in single and multiple widths. A call to your nearest Morse representative will bring you complete information on this *better* roller chain.

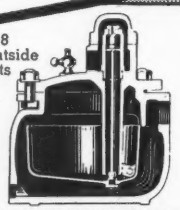
SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP

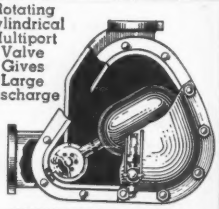
COCHRANE
"Drainage Equipment for a wide range of Operating Conditions..."

Only 8 parts—outside of bolts and pins



HEAVY DUTY BUCKET TRAP

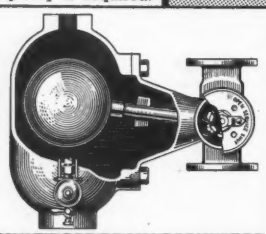
Rotating Cylindrical Multiport Valve Gives Large Discharge



Large cast-iron bucket holds valve tightly to seat until water overflows rim, opening valve wide.

MULTIPORT DRAINER

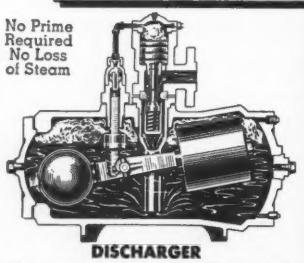
For handling drainage of low-pressure separators or other apparatus where large discharge capacity is required.



MULTIPORT DRAIN REGULATOR

Continuous discharge is maintained by height of condensate in body. Valve shuts off discharge when condensate falls to normal level. Tremendous discharge capacity.

No Prime Required
No Loss of Steam



DISCHARGER

For removing large quantities of condensate under high pressure (150 to 2000 lb./sq. in. or higher) from heaters, purifiers, coils, etc.

COCHRANE CORPORATION
3106 N. 17th Street, Philadelphia, Pa.

COCHRANE

Cochrane Corp., 3123 N. 17th St., Phila., Pa.
Please send me copies of your Publications on Condensate Drainage.

Name.....
Firm.....
Address.....
City..... State.....

has been moved to larger quarters adjoining the warehouse with W. E. Addicks, District Manager in charge.

Paul H. Gotschall, efficiency engineer for 10 yr. at Spy Run Station of Indiana Service Corp., has been appointed Superintendent of Power Production. He was a graduate in Electrical Engineering at Purdue University in 1920 and with Ft. Wayne Works of General Electric Co. until 1922. From 1922 he has been with the Indiana Corporation on construction and electrical design.

The Board of Directors of Pittsburgh Piping & Equipment Co., Pittsburgh, Pa., announce the election of the following officers: Charles R. Rall, President and Treasurer; Louis K. Hamilton, Vice President; Joseph G. Gardner, Secretary; Karl F. Tiegel, Director of Purchases and Estimates; G. Sinding Larsen, Chief Engineer.

Ervin Manske, Milwaukee boy who joined the Allis-Chalmers Mfg. Company in 1910 as a stenographer in the shipping department, has recently been appointed General Traffic Manager of the company's eight plants, with headquarters in Milwaukee. Mr. Manske was transferred to the home office Traffic Department in 1913, serving successively as stenographer, clerk, rate clerk and chief clerk, and since 1929 as Assistant General Traffic Manager under the late Frederick C. Bryan, whom he now succeeds.

Crane Co., Chicago, Ill., announces the election of V. P. Rumely as Vice President in Charge of Manufacturing, to succeed Mr. J. H. Collier who was made President earlier this month. Mr. Rumely has been Works Manager of the Crane Chicago plant for the past 4 yr., during which he has been very closely associated with Mr. Collier. Born in La Porte County, Ind., Mr. Rumely studied mechanical engineering at Purdue University, and later at the University of Wisconsin, graduating in 1912. In 1914-15 he was with the Buick Motor Co., and in 1916 went to the Hudson Motor Co. Starting in the Hudson shops, he progressed through every stage of production management to Superintendent and Factory Manager, the position he held when he resigned to join the Crane organization in 1937.

Announcement has recently been made by the Iron Fireman Mfg. Co. of the promotion of T. A. Marsh, formerly Central Division Engineer in Chicago, to the post of National Industrial Engineer at the Iron Fireman plant in Cleveland, Ohio. In his new position Mr. Marsh will be a member of the factory engineering staff.

J. M. Howell has been recently appointed works manager of Schenectady Works of General Electric Co., succeeding E. D. Spicer who becomes assistant to the vice-president in charge of manufacturing.

Mr. Howell joined General Electric in 1901 in the Switchboard Department, transferring to Cost Department in 1905, since which time he has been section head, head of turbine and control costs, chief cost accountant, works accountant and assistant works manager.

Mr. Spicer, after graduation as mechanical engineer from Cornell University, became chief engineer and factory manager for Kerr Turbine Co. and came to General Electric Co. in 1924 in the manufacturing department.

BUY WITH CONFIDENCE

Unless a product or service is of real benefit to the user, it cannot long withstand the glaring light of advertising.

Manufacturers of boilers, stokers, turbines, engines, pumps, piping, belting, motors and other equipment, who continue to advertise, must have products which have proved their worth by useful service. You can place full confidence in them and depend on them to deliver utmost value.

If you read the advertisements of such concerns, which are found regularly in POWER PLANT ENGINEERING, and study their messages, you can be confident of buying trustworthy power plant machinery and equipment from these progressive advertisers.

By taking full advantage, too, of the valuable installation and operation information given in the many new catalogs and special bulletins issued by manufacturers, you will gain greatly in up-to-date knowledge.

Let us know if we can help you solve any perplexing operation problems which come up in your daily work; or if you would like us to secure catalogs or data for you on any particular type of power equipment.

Address the Reader Service Department, POWER PLANT ENGINEERING. There is no charge, of course, for this service.

★ ★

When you need Iron-Body Wedge Gate Valves

Some of the Kennedy Iron-Body Wedge Gate Valve Types

Standard outside-screw-and-yoke screwed valve

Standard outside-screw-and-yoke flanged valve

Low-pressure non-rising stem flanged valve

Low-pressure outside-screw-and-yoke flanged valve

175-lb. outside-screw-and-yoke screwed valve

175-lb. non-rising stem flanged valve

250-lb. non-rising stem screwed valve

250-lb. outside-screw-and-yoke flanged valve

. . . . . look up the many advantages of Kennedy design *in the new Kennedy Catalog*

For example, the standard Kennedy iron-body wedge gate valves have more than three dozen advantageous features which are not to be found in any other single standard wedge gate design. These features include bronze bushings at all stem contact surfaces, rust-proof swing bolts with washer type nuts on outside-screw-and-yoke valves, one-piece yoke and separate yoke cap with four bolts and lubricating hole for thrust collar on outside-screw-and-yoke valves, bolts (no studs) used throughout, with nuts on top flanges (not underneath), lugs on screwed ends and reinforcing webs on flanged ends, and many other elements for greater convenience, longer life and more effective service.

Each of the other Kennedy valve types, too, has distinctive features of interest to every valve user—fully described in the new 240-page letter-size cloth-bound Kennedy Catalog.

The Kennedy Valve Mfg. Co. . . . . Elmira, N. Y.

Send the coupon for your copy

The Kennedy Valve Mfg. Co., 2006 E. Water St., Elmira, N. Y.
Please send copy of your new 240-page catalog.

Name .....

Position .....

Company .....

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KENNEDY

Extra Values in VALVES and PIPE FITTINGS

The number of Pairs of Wearing Rings Depends on the Amount of Pressure to be Held

The Accurate Packing COMBINATION for High Pressure Jobs

For nearly half a century, France "Full-floating" Metal Packing has proved its stamina, its ability to keep on giving service long beyond a "reasonable expectancy." It is the accurate packing combination (full-floating rings in a metal case) for the efficient sealing of compressor, engine and pump stuffing boxes regardless of pressure, temperature, vapor or gas conditions.

Constructed of few parts. Simple to install, inspect or clean. The type illustrated can be provided with a vent connection in addition to a lubrication connection, if desired.

ORIGINAL FRANCE METAL PACKING
Sold on approval
Satisfaction Guaranteed

For longer service and lower operating costs, specify FRANCE, the accurate packing combination that l-a-s-t-s. Write for Catalog M-5.

THE FRANCE PACKING COMPANY
Tacony Philadelphia Penna.
Branch Offices in Principal Cities

Original **FRANCE METAL PACKING**

OBITUARIES

C. B. Nolte

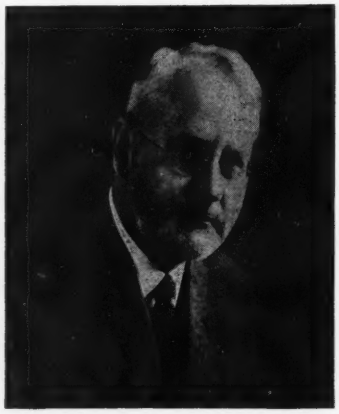
CHARLES BEACH NOLTE, President and Director of Crane Co., Chicago, Ill., since March, 1935, who died on April 29 was born in Mattoon, Illinois, December 28, 1885. After attending the public schools of Mattoon, Mr. Nolte matriculated at the University of Illinois, where he graduated with the degree of Bachelor of Science in Mechanical Engineering in 1909. From May to October, 1909, Mr. Nolte was a mechanical engineer in the Engineering Experiment Station at the University of Illinois. He then joined the Robert W. Hunt Co., engineers, of Chicago.

The connection with the Robert W. Hunt Co., was the beginning of a career which was to see Mr. Nolte rise successively from engineer (1909-1912), to manager (1912-1923), then Vice President and General Manager as well as a member of the Board of Directors (1923-1930), then President and General Manager and member of the Board of Directors (1930-1935). Mr. Nolte was also President and Director of the Crane subsidiaries, including Crane Ltd., Montreal; Crane Export Corp., Crane Enamelware Co., Canadian Potteries, Ltd., Warden-King, Ltd., Port Hope Sanitary Manufacturing Co., and also was Chairman of the Board of Trenton Potteries Co., Trenton, N. J., another Crane subsidiary.

Mr. Nolte was a trustee of the Illinois Institute of Technology and the Washington and Jane Smith Home, both in Chicago. Organizations of which Mr. Nolte was a member are the American Society of Mechanical Engineers, American Society of Civil Engineers, American Society for Testing Materials, American Railway Engineering Association, Western Society of Engineers, Newcomen Society, Chicago Engineers Club, in addition to the Chicago Club, Union League Club, University Club and South Shore Country Club.

George H. Danner

GEORGE H. DANNER, President and General Manager of Pittsburgh Piping and Equipment Company, Pittsburgh, Pa., died at the age of 66, on April 11,



SAUERMAN
POWER SCRAPERS

Best and Most Economical System of Storing Coal

The problem of storing coal safely and economically has been solved permanently at hundreds of steam generating plants both large and small by installing Sauerman Power Drag Scrapers. This system of handling coal has no equal for simplicity of installation and operation, nor does any other method of storing and reclaiming carry as positive an assurance as the Sauerman system of building a coal-pile that will be free from the chance of spontaneous combustion.

Write for Catalog

SAUERMAN BROS., INC.
486 S. Clinton St., Chicago, Ill.

How Advertising Speeds Progress

Besides raising our standards of living, good advertising greatly shortens the time between invention and utilization, which speeds the progress of new industries, helps make men and machinery more productive.

DEFENSE AND THE FUTURE...

Copy of Letter to users of Products of The International Nickel Company, Inc.

The International Nickel Company, Inc.

EXECUTIVE OFFICES: 67 WALL STREET

ROBERT C. STANLEY,
PRESIDENT.

New York, April 17, 1941.

Dear Sir:

Our plants, in common with those of most of America's industrial units, are working at their peak on defense production. In spite of this, hardship is being inflicted upon many consumers of our products who in the past have aided us in building a great business, and upon whom we must depend for our future success.

As this letter is written the monthly production rate of The International Nickel Company of Canada, Limited is already 20% above last year; three times that of 1929 and four times the peak rate of the last war. Its facilities have been increased to supply current defense demand and further increase in output will be available this year.

Upon the conclusion of this devastating war the future success of your business and ours will depend in large measure upon the retention of the good will of our customers. Any effort we can make, not conflicting with our full support of the defense program, should be directed toward this vitally important objective.

To this end we wish to offer our services especially to those customers whose requirements cannot for the moment be filled. One practical means of rendering such service is to offer you the assistance of our technical staff in solving problems of material arising from the temporary lack of nickel.

Our problems are complex and constantly changing and can only be solved through cooperation. As we see it, a large part of the solution lies in making clear the situation which we face. Your help and advice will be of invaluable assistance. It is our purpose to follow this letter with a personal call from one of our representatives, if you so desire, who will discuss with you in more specific detail our mutual problems.

Yours very truly,

R. C. Stanley

PRESIDENT.

RCS:JJS

LONG LIVE THE DART UNION

...and it does

The Dart Union has loyal rooters from one end of the country to the other . . . in fact, in many parts of the world. And for *very good reasons.* Darts have matched bronze seats that are ground to accurate "true-ball" surfaces. They have nuts and bodies of air refined malleable iron. And as a result—Darts have the grip of a bull dog, more lives than a cat. They get tight *quicker,* stay tight *longer*—and can be re-installed over and over again. They resist corrosion and pipe strains—take wrench abuse. Want proof? Send for a Dart to try *free.*

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

in Pittsburgh. Mr. Danner was one of the original founders of the company nearly 40 yr. ago and served as President since its organization.

Charles B. Jahnke

CHARLES BERNHARDT JAHNKE, president and general manager of The Cooper-Bessemer Corp., died at Mercy Hospital in Mount Vernon, Ohio, on Tuesday afternoon, May 6, 1941, from a heart attack, suffered while he worked in the garden of his home.

Born in Cincinnati, Ohio, in 1889, Mr. Jahnke graduated from the University of Cincinnati and for 21 yr. was associated with Fairbanks, Morse & Co. as chief engineer, works manager, and finally director of engineering. In 1931 he joined the International Harvester Co. Fours years later he became affiliated with The Cooper-Bessemer Corp. as chief engineer, becoming in 1937 a vice-president and general manager and in December, 1940, was elected to the office of president and general manager.

William T. Randall

WILLIAM T. RANDALL, Philadelphia Sales Engineer of the Pangborn Corp., died suddenly of a heart attack on April 14. He was 57 yr. old, a native of New England, who settled early in Philadelphia, and joined the Corporation in 1919. He was widely known for his services to the foundry and process industries during the past 22 yr.

W. S. Richhart

WILLIAM S. RICHHART of Ft. Wayne, Ind., superintendent of power production at Spy Run plant of Indiana Service Corp., died on Apr. 9, while at the meeting of Midwest Power Conference in Chicago. He had been with the Corporation since 1917 and in charge at Spy Run since March, 1938. He graduated from Purdue University in 1905, was with Allis-Chalmers Co., University of Pennsylvania, Westinghouse Electric & Mfg. Co. and Public Service Commission of Indiana before joining the Indiana Service Corp. He was a member of American Society of Mechanical Engineers and American Institute of Electrical Engineers.

E. W. Burbank

EDWARD W. BURBANK, former Manager of Allis-Chalmers Mfg. Company's Dallas, Texas, district office from 1922 to 1940, died April 20 after a prolonged illness which followed a stroke he had suffered in December, 1939. He started with the company as a student apprentice in 1911 after graduating from Tulane University, and served in a variety of engineering and sales work. He was a member of the American Society of Mechanical Engineers and had been on its board of managers.

MANUFACTURERS' NEWS

As announced by Charles E. Wilson, president of the General Electric Co., more than 100 subcontractors are now working on defense contracts for the Erie, Pa., plant, 95 for the Schenectady Works and 91 vendors for works at Lynn and West Lynn, Mass. New factories have been erected, two and three shift operation is in effect, but additional subcontractors are needed to expedite deliveries. Work needed includes tools, dies, jigs, screw machine parts, wood and metal patterns, forgings, castings, machine tool work, such as turning, boring, planing, milling, grinding, tapping, metal fabrication by all types of welding. Correspondence should be sent to Purchasing Dept., Room 133, Gen. Elec. Co., Schenectady, N. Y., stating types and quantities of work for which applicants are equipped and tolerances which can be held in production.

Whiting Stokers will now be manufactured and sold from the plant of Whiting Corp. at 4711-19 W. North Ave., Chicago, Ill.

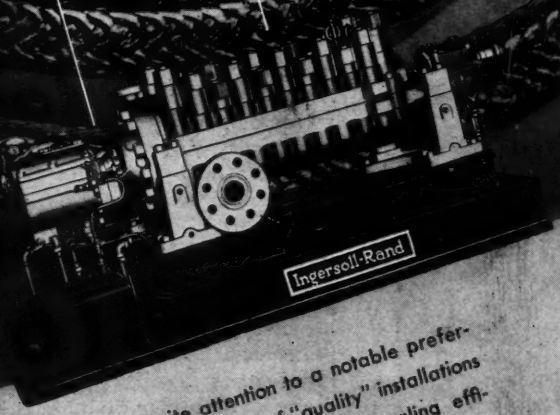
George W. Graham will continue as president, with A. E. Bottenfield in charge of distribution.

In domestic sizes, the Standard line from 10 to 38 lb. per hr. in four models, and the Deluxe line, 28 to 88 lb. per hr. in five models will be carried. Whiting Industrial Underfeed line will also be produced in sizes to 800 lb. per hr., with overfeed and spreader line in sizes from 500 to 16,000 lb. per hr.

BULLSEYE *by a* PAIR OF ACES

PUMP *by* INGERSOLL-RAND

PACKING *by* JOHN CRANE



Abstract OF INSTALLATION

PROBLEM:
Pumping boiler-feed water at 405° F to 420° F; discharge pressure 1550 to 1700 pounds; suction pressure 450 to 500 pounds . . . .

EQUIPMENT:
Ingersoll-Rand Cameron Class CHT Multi-Stage Vertically Split Barrel-type heavy duty, high pressure Boiler Feed Pump . . . .

PACKING ADAPTATION:
John Crane Style 804-MBF on Nitralloy sleeves . . . .

SOLUTION:
100% performance . . . .

LOCATION:
(Data on request).

. . . . Opportunity is taken here to invite attention to a notable preference for John Crane Packings—one of a long series of "quality" installations where John Crane Style Packing demonstrated spectacular sealing efficiency . . . Yes, more than 98% of the "incurable" problems submitted to our technical staff have been solved. John Crane recommendations, based upon scientific analysis and procedure are offered without obligation.

CRANE PACKING COMPANY, CHICAGO, U S A
CRANE PACKING COMPANY, LIMITED, HAMILTON, ONTARIO, CANADA

● Four EYE-HYE Gages guard the 450 lb. boilers at Riverside Station, Moline Rock Island Mfg. Co., Davenport, Iowa.

EYE-HYE

Assures You More Safety and Economy in Boiler Operation

...because it brings water level reading down where operators see it often . . .

● It's no wonder you hear of new EYE-HYE installations every day. This new means of placing an accurate dependable water gage any reasonable distance from the boiler drum is something power men always wanted—a water level *instrument* that practically forces frequent reading.

Attendants read EYE-HYE's brilliant green indicator, illuminated, at eye level—quickly, more accurately. Made for all pressures and for wall or panel mounting. Easy to install, operates day after day without trouble. Hundreds of plants equipped with EYE-HYE are admirably set up to maintain safe continuous operation. Write today for Bulletin 382.

THE RELIANCE GAUGE COLUMN CO.
5902 Carnegie Avenue • Cleveland, Ohio

Reliance
TRADE MARK · REG. IN U.S. PAT. OFF.
Boiler Safety Devices since 1884

Foxboro Co. is erecting a building for service department and offices at 5151 Baum Blvd., Pittsburgh, Pa., to cover parts of Penn., W. Va., Ohio and Ky. A. H. Shafer will continue as Manager.

Capacity of South Meadow plant of Hartford Electric Light Co. will be increased to 175,000 kw. by installation of a 45,000 kw. turbine-generator now being built by General Electric Co. The new unit is similar to one installed in September, 1938, of tandem-compound, double-flow type, with hydrogen-cooled generator. Steam conditions will be 850 lb. gage pressure, 900 deg. F.

W. H. & L. D. Betz have removed to larger quarters at Gillingham & Worth Sts., Frankford, Philadelphia, Pa.

To house Nalcolite (Nalco's zeolite) department, which has shown a very gratifying growth, the National Aluminate Corp., Chicago, Ill., is completing a one story building across the street from the present factory, 200 by 48 ft. with loading platform, switch track and truck platform.

News from the Field

A.S.M.E. Semi-Annual Meeting

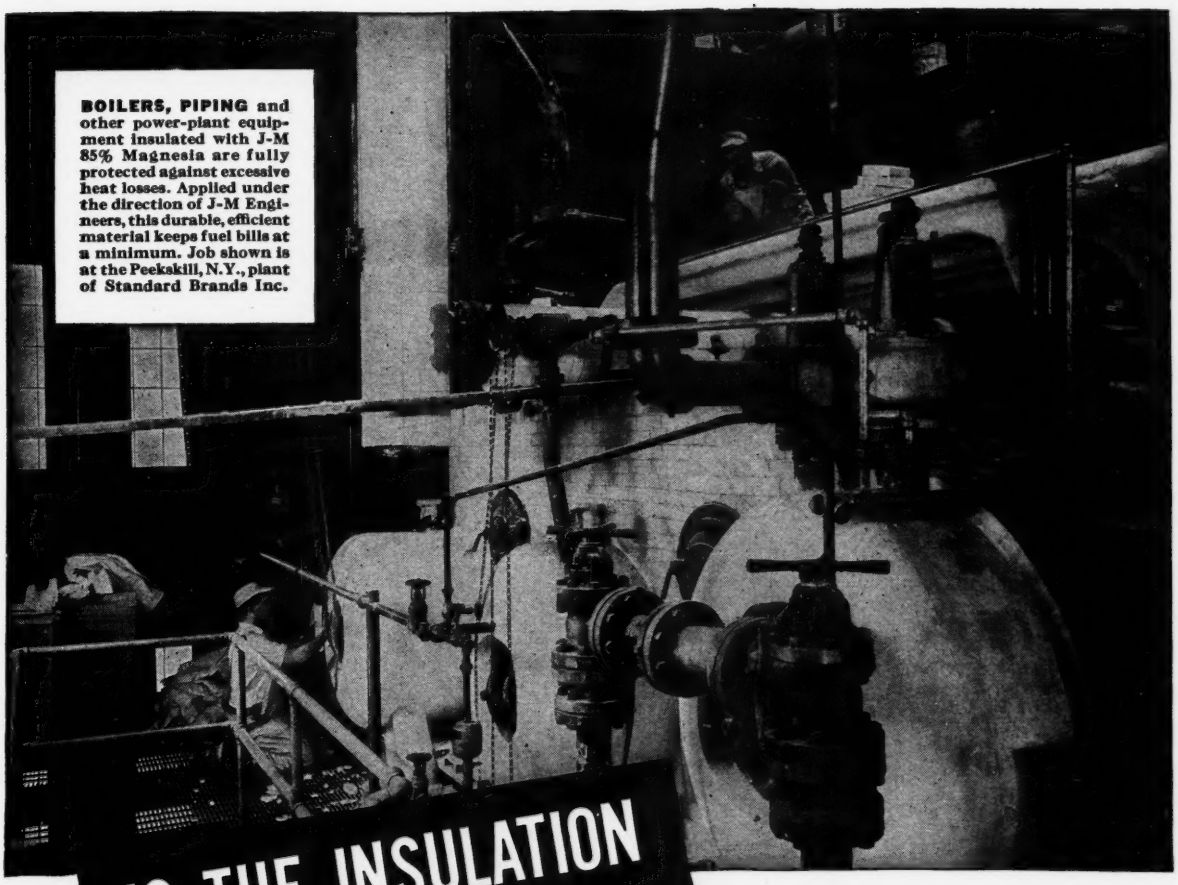
KANSAS CITY, Mo., will be host to the American Society of Mechanical Engineers June 16 to 20 during the Society's 1941 Semi-Annual Meeting which will be held in Hotel Muehlebach. Although the Oil and Gas Power Division of the Society will hold its meeting the previous week in the Hotel President, most of the other professional divisions will hold sessions during the week of the Semi-Annual Meeting, among these are: Power, Process Industries, Materials Handling, Fuels, Hydraulic, Heat Transfer, and Management.

Papers on the program of particular interest to power plant engineers are: Experimental Studies of Automatic Control, by J. C. Peters, Leeds & Northrup, Philadelphia, Pa. Flour Mill Air Conditioning, by George M. Sebree, Western Air Conditioning Corp., Omaha, Neb. Experiences at Des Moines with Large Condensing 3600 r.p.m. Turbo-generator and Accompanying Boilers, by J. F. McLaughlin. Some Air Heater Facts 1926 to 1941, by E. L. Hopping and D. F. Schick, Jr., Philadelphia Electric Co. Hand-Fired Smokeless Furnaces, by Julian R. Fellows and John C. Miles. Chain Grate Stoker Operation, by F. X. Gilg, Babcock & Wilcox Co, Orifice Design for Air-Lift Ice Prevention for Grand Coulee Dam, by T. C. Owen. Developments in Regulating Outlet Valves, by G. J. Hornsby. Development of High Temperature Steels for Tube Stills, by B. B. Morton, International Nickel Co., New York, N. Y. Calibration of Displacement Meters on Volatile Liquid Petroleum Fractions, by W. E. Jacobson, Gulf Research and Development Co. Cooling Tower Progress, by L. T. Mart, Pres., The Marley Co., Kansas City, Mo. Stability Characteristics of Turbine Oils, by L. C. Welch, Standard Oil Co. of Ind., Chicago, Ill. Welding of Boiler Tubes, by F. C. Hutchison, Linde Air Products Co., Kansas City, Mo. Fort Peck Surge Problem, by F. H. Littrell. Steam Turbine Regenerative Cycle, an Analytical Approach, by J. K. Salisbury, Turbine Engrg. Dept., General Electric Co. Functions and Requirements of Steam Turbine Control Systems, by A. F. Schwendner, Control Engr., Land Turbine Engrg., Westinghouse Elec. & Mfg. Co., Philadelphia, Pa. Coal Handling System for Central Stations, by Geo. Daniels, Commonwealth & Southern Corp., Jackson, Mich. Handling Dust and Fly Ash in Power Plants, by Elmer L. Hughes. Colloidal Fuel, by Dr. J. E. Hedrick, Kansas State College, Manhattan, Kansas. Midwest Fuels, by A. C. Foster, Foster Wheeler Corp., New York, N. Y.

A.S.T.M. Annual Meeting

DURING the week of June 23 to 27, the American Society for Testing Materials will hold its 44th Annual Meeting at the Palmer House in Chicago. At the same time there will be held the Sixth Exhibit of Testing Apparatus and Related Equipment and the Fourth Photographic Exhibit. Local arrangements are in charge of E. R. Young, Metallurgical Engineer of the Climax Molybdenum Co. of Chicago. Details of the program available from the society headquarters at 260 S. Broad St., Philadelphia, Pa.

The first day of the meeting will be devoted entirely to some 200 technical committee meetings. The first session of the convention proper will be held Tuesday morning. Among the topics of direct interest to the power field is a symposium on water for industrial uses, and will be held on Thursday afternoon, in charge of Max Hecht and R. E. Hall. This will



BOILERS, PIPING and other power-plant equipment insulated with J-M 85% Magnesia are fully protected against excessive heat losses. Applied under the direction of J-M Engineers, this durable, efficient material keeps fuel bills at a minimum. Job shown is at the Peekskill, N.Y., plant of Standard Brands Inc.

IS THE INSULATION IN YOUR PLANT ONLY HALF RIGHT?

ALMOST any insulation will save you some money on fuel. But to get fuel costs down to rock bottom . . . and to keep them there . . . it takes the *one correct insulating material*, applied in the *one most economical thickness*.

To assure every saving possible with insulation, leading power plants rely on the J-M Insulation-Engineering Service. J-M Engineers bring to your plant specialized technical experience and training that enable them to trace down sources of costly heat loss that might otherwise go unnoticed. Because they work with the complete J-M line of insulations, they can recommend the exact amount of the right insulation for your particular problem . . . help you make sure that your insulation investment pays maximum returns.

Whether you are planning on installing new power-plant equipment or interested only in checking heat economy on existing equipment, it will pay you to investigate this free J-M service. For complete information and data on all J-M Industrial Insulations, write for Catalog IN-55A. Johns-Manville, 22 East 40th Street, New York, N. Y.

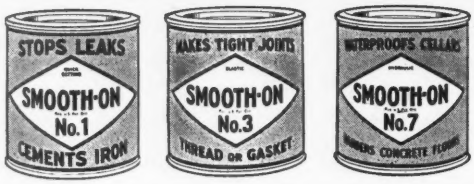
Johns-Manville INDUSTRIAL INSULATIONS

FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE . . .

Superex . . . 85% Magnesia . . . Asbesto-Sponge Felted . . . Sil-O-Cel . . . Marinite . . . Anti-Sweat . . . Rock Cork

These 3 Cements

will enable you to do hundreds of repair and maintenance jobs quickly and at low cost



Here are some of the many emergency repair and routine maintenance jobs you can do quicker and at less cost with these three Smooth-On compositions than by any other means:

Seal cracks in casings or shells of pumps, heaters, condensers, evaporators, tanks, engines, valves, etc.

Stop leaks at seams, bolts, rivets, threaded or flanged joints, etc.

Tighten loose parts of apparatus, fixtures, etc.

Waterproof walls, floors, cisterns, etc., of concrete, brick or stone

Seal Joints of threaded or flanged pipe and equipment connections

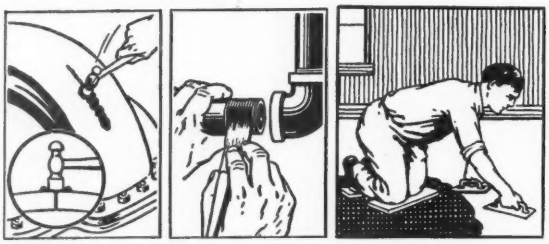
Anchor studs, bolts or screws in concrete, metal or wood

Re-surface damaged piston heads, valves, machine castings, etc.

Correct for misalignment of joints at connections of piping, equipment, machine bases, etc.

Reinforce thin or punctured metal weakened by force, corrosion or abrasion

This partial list of Smooth-On time-saving and labor-saving uses shows how *essential* these compositions are for every plant. Smooth-On is easy to apply, requires no heat, special tools, or previous experience, and each application saves the cost of the entire can many times over.



These Smooth-On compositions are sold in 1-lb., 5-lb. cans; and larger kegs. Smooth-On No. 1 is also sold in 1¾-oz., 7-oz. cans. For your protection insist on Smooth-On, used since 1895. Obtainable from your supply house or if necessary, from us.

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40-Page Handbook

Explains simply and concisely how to do each of the above and many other repair and maintenance jobs, with 170 illustrative diagrams. Send the coupon *today* for your copy of this helpful manual which every engineer should have and keep handy.

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***Do it with* SMOOTH-ON**

include sampling of steam and boiler water, determining conductivity correction factors for dissolved gases, calculation of corrections to conductivity measurements, degasification of steam samples, conductivity cells and electrical measuring instruments, and conductivity apparatus for use with boiler water and steam samples.

Another session of interest is on the effect of temperature on the properties of metals which this year will deal largely with low temperatures and carbon-molybdenum steels for high-temperature piping. Other papers will cover laboratory tests for the ignitibility of coal, a study of the grindability of coal and fineness of pulverized coal and measurement of water vapor in gases.

P. G. & E. Secures Water Rights for Hydroelectric Plants

THE PACIFIC GAS & ELECTRIC CO., San Francisco, Calif., has secured permits for water rights for two hydroelectric power developments, ultimately estimated to cost about $26,350,000, including power dams, generating stations, switchyards, transmission lines for connection with present high-tension system, power substations and miscellaneous structures. One grant (Permit No. 5724) covers the use of water on basis of 3500 cu. ft. per sec. from the North Fork of the Feather River in Plumas and Butte Counties. It is estimated that this plant will have an ultimate rating of 246,591 hp., and will represent an investment of $18,840,000. The other development covers a grant (Permit No. 5725) for the utilization of 525 cu. ft. per sec. from the Bear River in Nevada and Placer Counties; the proposed station will have an ultimate rated output of 82,389 hp., and will cost approximately $7,510,000.

Increasing manufacturing output without purchasing major equipment and without large-scale hiring of personnel was the theme of a conference held at the Hotel Astor, May 21 and 22, by the Production Division of the American Management Association. Shortages of machines and skilled men have in many cases created serious bottlenecks in defense industries. Representatives of some 20 industries took part in the symposium of practical experience in meeting these two obstacles.

At the annual meeting of The Okonite Co. and The Okonite-Callender Cable Co., Leland B. Duer of the legal department was elected director of the Okonite Co. and Charles E. Brown, Jr., of the Washington, D. C., sales office was elected vice president, and Albert F. Metz, treasurer, was elected director of both companies.

Manufacturers from 18 states, spread out from coast to coast, will display their latest products at the Pacific Heating & Air Conditioning Exposition, in the Civic Auditorium, in San Francisco, June 16-20, assuring a thoroughly representative showing of equipment.

California heating and air conditioning appliance manufacturers apparently will have large representation, though the heavy industrial populations of such mid-western areas as Illinois, Michigan, Wisconsin, Ohio and Indiana may contribute many exhibits, as indicated by advance reservations.

All types of heating, ventilating and air conditioning systems will be represented at the Exposition, as climatic conditions in the eleven western states from which attendance will chiefly be drawn include practically all the variations known to the temperate zone. Charles F. Roth, manager, indicates that special emphasis will be placed on systems appropriate to the milder atmosphere of the coastal region, where building activity is approaching a new peak at the present time.

Among papers to be presented at the annual convention of Smoke Prevention Association of America, Inc., at Hotel Ansley Atlanta, Ga., June 3 to 6, will be: Measurements of Solids in the Atmosphere, by David R. Morris, U. S. Weather Bureau, New York City, N. Y.; Owens Automatic Dust Recorder, by Wm. B. Schaum, Chief Smoke Inspector, Newark, N. J.; Firebox Action in Stoker Fired Locomotives, by G. M. Myers, Standard Stoker Co., Inc., Washington, D. C.; Volatile Content of Fuel and Smoke Production, by Stanley C. Higgins, New River Coal Operators Assn., Mount Hope, W. Va.; Boiler Furnace Design, by G. A. Heard, The M. H. Detrick Co., Chicago, Ill.; The Consumer in Government Regulation of Bituminous Coal, by Paul Sifton, Consumers' Council Division, Washington, D. C.; Spreader Stoker Operation as Affecting Air Pollution, by Earl Beckwith, Detroit Stoker Co., Chicago, Ill.; Air Pollution and Public Health, by I. Hope Alexander, Department of Public Health, Pittsburgh, Pa.

"...AND IT'S AS SIMPLE TO SET AS LETTING AIR INTO—OR OUT OF—AN AUTOMOBILE TIRE!"

A Foster Type 39-Q1 Pressure Reducing Regulator being loaded by a hand pump. This type is built for initial pressures up to 2500 pounds per square inch; for delivery pressures up to 1200 pounds per square inch; and for temperatures up to 1000 degrees Fahrenheit. In addition to this single-seated type, double seating is available in the Foster Type 39-Q2.

This eight-page, fully-illustrated bulletin containing practical and useful information (application, features, operation, installation — also dimensions and weights) on the Foster Type 39-Q1 and 39-Q2 Pressure Reducing Regulator is just off the press. A copy will be sent to you without cost . . . simply ask for Catalog 70, Bulletin 10.

Simplicity of loading *is* one of the outstanding features of the new Foster Type 39-Q1 Pressure Reducing Regulator—but this valve has *other* features, too, that insure top performance.

There are no operating springs, no weights in this simple regulator. A constant load is imposed by the air in the dome — accuracy of regulation is unaffected by spring deflection and hysteresis.

Adjustment? Simply change the dome load and you change the delivery pressure. A few strokes of a hand pump or a "shot" from a compressed gas bottle increases the delivery pressure, while opening the check valve in the dome decreases the delivery pressure.

Maintenance? There are no large sliding surfaces or side thrusts, no stuffing boxes—so few moving parts that this valve can be installed and forgotten between routine inspections — which, incidentally, can be made in a matter of minutes.

If *accurate* regulation or control of steam, hot gases, or hot liquids is your problem, why not send for complete information on this valve, or send a summary of your service conditions—now?

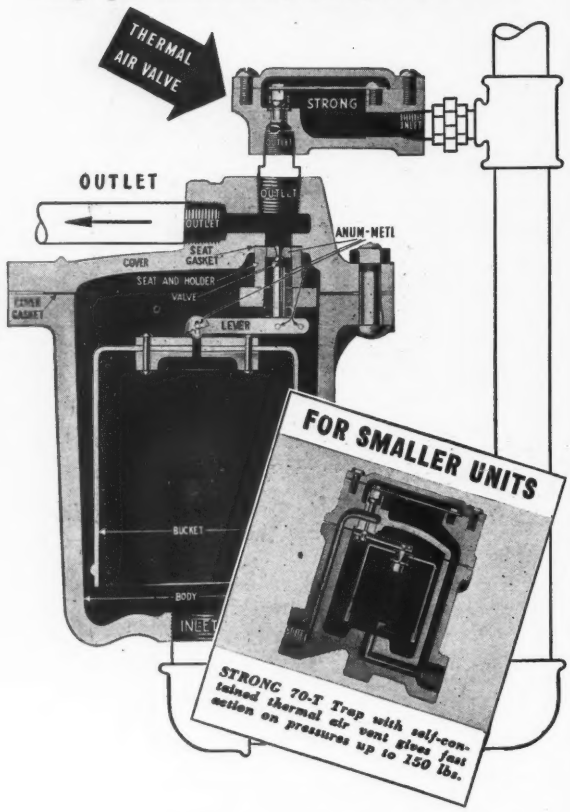
FOSTER ENGINEERING Company

PRESSURE REGULATORS • RELIEF AND BACK PRESSURE VALVES • AUTOMATIC STOP AND CHECK VALVES • ALTITUDE VALVES • DAMPER REGULATORS • FAN ENGINE REGULATORS PUMP GOVERNORS • TEMPERATURE REGULATORS • LIQUID LEVEL CONTROLLERS • FLOAT AND LEVER BALANCED VALVES • NON-RETURN AND TRIPLE DUTY VALVES • VACUUM REGULATORS OR BREAKERS • SIGHT FLOW BOXES • STRAINERS • SAFETY VALVES

111 MONROE STREET • NEWARK, N. J.

STRONG THERMAL AIR VALVE

By-passes Air, Stops Steam



STRONG stopped using a thermal air vent on the trap bucket years ago. Reason: air had to pass through the trap discharge valve, which limited the air capacity and slowed up heating.

STRONG'S Thermal Air Valve provides a large, unrestricted air by-pass. You get **FAST ACTION.** Anum-Metl seat and disc, plus the special bi-metal thermal element, insure long, trouble-free service. Write for Catalog 63 for details.

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

STRONG
STEAM SPECIALTIES

FOR THE ENGINEER'S LIBRARY

Coupon for obtaining free literature listed here may be found on page 140, under the heading Helpful Bulletins.

Electrical Equipment

1 **Electrical Instruments**—A 12 pp. catalog, E-54(4), describes new portable equipment for measuring, at a normal test voltage of 10,000 v., the power factor and capacitance of installed bushings, insulators and other high-voltage dielectrics. Safety features protect the operator from high-voltage. Leeds & Northrup Co.

2 **Switches**—A new 76-pp. catalog No. 126 entitled Square D Digest, contains listings and prices on safety switches, service equipment, multi-breakers and other circuit breakers, panelboards, motor control and pressure switches. Square D Co.

3 **Switchgear**—Metal-Clad vertical-lift switchgear is the title of a new 24 pp. colored bulletin B6012A which describes its various applications and construction, also included is data on circuit breakers with standard voltage current, and interrupting ratings. Allis-Chalmers Mfg. Co.

4 **Motor**—Bulletin GES-2677 ilustrates and tells how to start and protect a synchronous motor for best results and also gives little-known facts about control for synchronous motors. General Electric Co.

5 **Regulators**—A new 15 pp. booklet describes type BJ voltage regulators for generators with indirect acting exciters. The application to medium and large size a.c. generators as well as synchronous motors and condensers is discussed. Distinctive features are also listed. Operating details are given along with a tabulation of complete equipment for controlling a typical a.c. machine. Response, parallel operation, and line drop compensation are discussed. Schematic wiring diagrams and typical layouts aid in the explanation. Westinghouse Electric & Mfg. Co.

Instruments and Controls

6 **Instruments**—A 28 pp. catalog, C-40, describes a complete line of thermometers and hydrometers with suggestions for insuring correct readings, selection chart and tables for converting gravity readings. George Ruehfel Co.

7 **Feedwater Control**—Bulletin 431, Operating Experience at Ruppert Brewery with the Copes Flowmatic Regulator, is an 8 pp., 8½ by 11 in. article in which J. G. Morrow, assistant plant superintendent for Jacob Ruppert describes the brewery's modernized boiler plant, with particular reference to the unusually close boiler water level control being obtained. Northern Equipment Co.

8 **Control**—Bulletin GEA-2176 describes self-synchronous apparatus for remote signaling, control and indication. Also included are applications and illustrations. General Electric Co.

9 **Control**—A 4 pp. Bulletin GEA-3571 describes plugging control equipment and gives applications of the plugging switch. General Electric Co.

10 **Control**—A new 12 pp. bulletin GES-2456 entitled More For Your Control Dollar illustrates and describes various types of combination starts and their applications in industry. General Electric Co.

Pumps and Traps

11 **Centrifugal Pumps**—Bulletin W-350-B7 deals with process pumps for chemical and allied industries in capacities 450 to 3000 g.p.m. at heads of 15 to 100 ft. Worthington Pump and Machinery Corp.

12 **Pumps**—A new comprehensive 40-pp. Bulletin B-6146 for every pumping service requiring a high grade single-stage double-suction centrifugal pump has recently been released. In addition to construction features, pump dimensions, normal and special application data, this profusely illustrated bulletin presents friction tables, head-capacity tables, and other valuable pump engineering information. Allis-Chalmers Mfg. Co.

13 **Glass Pump**—Bulletin 336 illustrates and describes glass centrifugal pumps for handling corrosive liquids, sizes ¾ and 1 in. Nash Engineering Co.

14 **Air Traps**—Data on removal of water from compressed air are given in Bulletin 143 which describes Armstrong air traps and their applications. Armstrong Machine Works.

DEPENDABLE POWER

De La Vergne Diesel Engines

● Today's production requirements demand uninterrupted power supply. World conditions make it imperative that every possible safeguard be taken to prevent power failure.

Your best insurance for an uninterrupted power supply is a De La Vergne Diesel Engine. Known throughout the country for their dependable and economical operation, De La Vergne Diesels are available in sizes from 200 bhp to 1,500 bhp. Let De La Vergne engineers investigate your power problem.

Baldwin De La Vergne Sales Corporation, Philadelphia, Subsidiary of The Baldwin Locomotive Works.

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SUBSIDIARY OF THE BALDWIN LOCOMOTIVE WORKS
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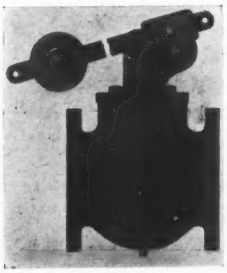
Automatic RELIEF VALVES

THE DAVIS LINE (Standard Items)	For Steam, Air and Gas *Also Water and Oil											For Steam								
Valve No.	*13R	*14R	15R	16R	*18R	*19R	49	180R	182R	260	*261	*401	80	81	82	110 110B	111 112	113	113B	116 117	116B	265
Service: Pressure Relief to Atmosphere												✔	✔	✔	✔				✔		✔	
Service: Pressure Relief into L. P. Lines		✔	✔	✔																		
Service: Vacuum Relief		✔	✔	✔	✔	✔																
Service: Pump By-Pass	✔							✔														
Service: Protection of Major Equipment										✔	✔					✔	✔	✔	✔	✔	✔	✔
Max. Relief Pressure	100	150	30	125	50	100	200	150	500	50	15	500	20	20	20	Atmos.	Atmos.	Atmos.	10	Atmos.	10	250
Single Seat	✔				✔	✔	✔			✔	✔					✔	✔	✔	✔	✔	✔	✔
Double Seat		✔	✔	✔			✔	✔	✔			✔	✔	✔	✔							
Diaphragm Actuated	✔	✔	✔	✔	✔	✔		✔														
Piston Actuated									✔													
Direct Disc Actuated										✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Auxiliary Pilot Control							✔					✔										
Spring Loaded	✔	✔				✔	✔	✔	✔	✔	✔	✔										✔
Weight Loaded			✔	✔	✔								✔	✔	✔				✔		✔	
Range of Sizes, Sc'd	3/4"-2"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	2"-4"	2"-4"	1/2"-4"	2"-6"	2"-6"	2"-6"							
Range of Sizes, Fl'g'd	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-4"	2"-8"	2"-8"	1 1/2"-14"	2"-24"	2"-24"	2"-24"	6"-10"	6"-48"	6"-30"	6"-30"	6"-30"	6"-30"	4"-20"
Material Specifications: Body: Bronze	✔	✔	✔	✔	✔	✔	✔	✔	✔			✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Material Specifications: Body: Semi-Steel	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Material Specifications: Body: Steel	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔										
Material Specifications: Trim: Bronze	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Material Specifications: Trim: Nickel Iron		✔		✔			✔															
Material Specifications: Trim: Monel	✔	✔	✔	✔	✔	✔	✔	✔	✔			✔										✔
Material Specifications: Trim: Stainless Steel	✔	✔	✔	✔	✔	✔	✔	✔	✔			✔										✔

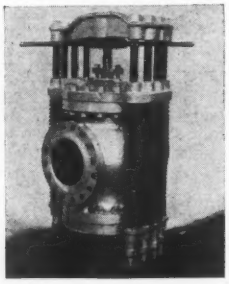
for Every Job

PRESSURE RELIEF • VACUUM RELIEF
ATMOSPHERIC RELIEF • PUMP BYPASS

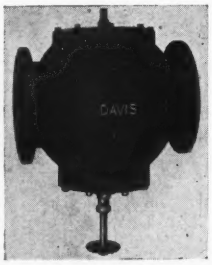
USE the check list above to determine the proper type of relief valve for your job. It lists valves suitable for every relief service, including valves designed for full pipe capacity at rated relief pressure with minimum accumulation. Hand testing levers may be incorporated on most designs. Manual control and stay-open features are available on atmospheric relief valves. Send data on your service conditions for complete recommendations on the proper valves for your plant. DAVIS REGULATOR CO., 2508 S. Washtenaw Ave., Chicago, Ill.



Above—No. 80 "Noiseless" semi-balanced Back Pressure Valve for exhaust lines.



Right — No. 110 Exhaust Relief Valve for condenser protection service.



Left—No. 265 Turbine Bleeder and High Pressure Relief Valve.

DAVIS AUTOMATIC VALVE SPECIALTIES

Compressors and Blowers

15 **Compressors**—A 32 pp. catalog No. 37 describes multi-stage, high-pressure air and gas compressors. Fully illustrated, the catalog also gives reference to standard types and special service compressors. Norwalk Co., Inc.

16 **Blowers**—A new bulletin, No. B-6104, on Multi-Stage Turbo-Blowers such as used in handling air or gas for diverse applications like blast furnaces and convertor blowing, gas boosting and exhausting, agitating and aerating, circulating gases in chemical plants and compressing refrigerants, has recently been released. Its 32 pp. of well-illustrated material cover centrifugal type blowers built in standard sizes for inlet volume up to 130,000 cu. ft. per min., and larger, for air pressures up to 35 lb. gage. Allis-Chalmers Mfg. Co.

Valves and Piping

17 **Valves**—New Catalog 77-1, Brown and Minneapolis-Honeywell Industrial Power Units and Motorized Valves, describes motor power units and motorized valves to operate with Brown Control Instruments as an important part of the control system. Included are illustrations of electric control motors, for globe, butterfly, three-way and special valves, with dimension tables and schematic diagrams. The Brown Instrument Co.

18 **Blow-Off Valves**—Typical uses for valves are shown in a 4 pp. folder titled, Physically Fit to Shoulder Their Jobs for National Defense. Illustrated are various types and uses. Homestead Valve Mfg. Co.

Heat

19 **Heat**—Bulletin GEA-3539 describes and gives applications of the flexible, lead-covered heating cable. Also included are illustrations and cable specifications. General Electric Co.

20 **Heaters**—Bulletin 41 entitled Hotstream Heaters is a 44 pp. catalog, illustrating and describing various types of water heaters, thermostats, relief valves, safety controls and other accessories pertaining to water heaters. Hotstream Heater Co.

Refractories

21 **Refractories**—Insulating Fire Brick, Bulletin No. 103, describes the Narco products and gives charts of temperature reduction and heat saving. North American Refractories Co.

22 **High Temperature Coatings**—Three new single sheet bulletins have recently been issued. Bulletin 90 covers Preferred Pyro-Proof, a high temperature coating which is said to withstand 4000 deg. F. and used to protect refractory walls and furnace linings; Bulletin 950, covers Preferred White Hot, a high temperature coating and heat reflecting agent for maximum temperatures of 2840 deg. F. and which will adhere to such surfaces as refractories, ceramics, glass, metals, exhaust pipes of internal combustion engines, high temperature stacks, breechings, steam lines, etc.; Bulletin No. 700 covers Preferred Sludge-Go, used in the normal proportion of one pint to 500 gal. of fuel oil for cleaning out sludge in fuel oil tanks and pipe lines, preventing accumulations in strainers, footvalves, relief valves and suction lines. Preferred Utilities Mfg. Corp.

Metals

23 **Metals**—A heavy cardboard slide selector showing the physical properties, chemical compositions and applications of various grades of Ampco Metal is now being distributed. Ampco Metal, Inc.

24 **Copper and Alloys**—Three catalogs on Copper and Copper Alloys, for use in Process Industries, in Mechanical Industries and in Power plants have been recently released. Each is a 24 pp. booklet giving properties, composition and uses. Revere Copper and Brass, Inc.

Miscellaneous

25 **Oil Burning**—Burning Fuel Oil is the title of a new 26 pp. booklet which deals with various grades of fuel oil, its composition, combustion and atomization; fuel oil testing, fouling tendencies of oil, etc. Also included is a description and use of Liquid Kleen-Flo, an oil conditioner, in burning fuel oils. Combustion Service Co.

26 **Coal Handling**—A recently issued catalog No. 1807 deals with buckets for coal and coke handling. Described and illustrated are light and medium weight units; two line lever arm buckets for cranes, derricks and whirleys; high speed coal tower buckets of the two-line type; and four-rope buckets to operate on bridge and gantry type cranes. Diagrammatic explanations of technical features,

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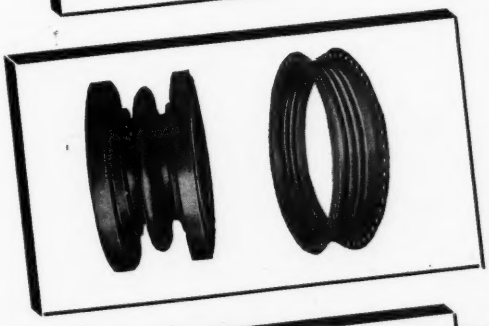

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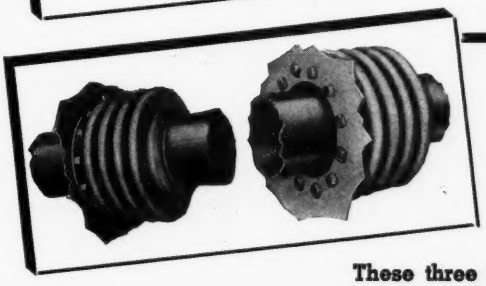
Excellent for absorbing expansion and vibrations between adjacent equipment such as turbines and condensers, pumps or compressors and pipelines, tanks and pipelines, etc. Special Copper or Stainless Steel; other metals to order.



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Combines absorption of pipe expansion where piping passes through walls, foundations or tanks, and sealing of the openings so that no moisture leaks in or out past the pipe.

These three phases of Badger Expansion Joint service cover just about all of industry's requirements along these lines . . . and they are covered by our experience which cannot be equalled elsewhere. We'll be glad to hear about your problem.

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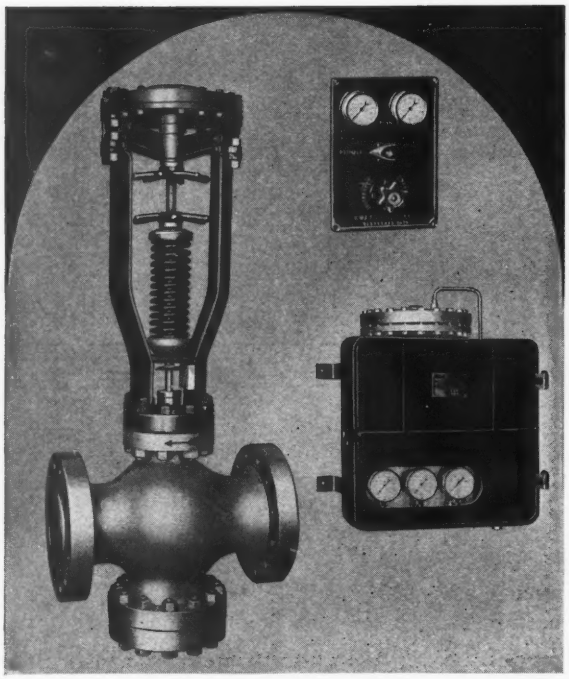

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include an analysis of cable life and a table on bucket capacities. Blaw-Knox Co.

27 **Torches and Furnaces**—A recently released bulletin illustrates and describes various types of torches and furnaces for welding, soldering, annealing, melting metal and many other applications. Insto-Gas Corp.

28 **Arc-Welding**—Recently released Bulletin GEA-569F illustrates and describes multiple-operator arc-welding systems for manual or machine welding with metallic or carbon electrodes. General Electric Co.

29 **Boilers**—In a recent 8 pp. catalog, V-L water tube boilers are illustrated and described. Included are design features, construction and dimensions. Erie City Iron Works.

30 **Metal Hose**—Bulletin 55-F gives a brief but thorough description of Penflex, a flexible all-metal hose for tank cars. Included are illustrations and specifications. Pennsylvania Flexible Metallic Tubing Co.

31 **Tubes**—Data Card No. 107A gives a revised list of standard specifications for seamless tubes and pipe, in handy finger-tip form. The Babcock & Wilcox Tube Co.

32 **Tubing**—Card folder No. 103A lists seamless tubing wall thickness data in millimeters and inches, and compares the various gages in use today. The Babcock & Wilcox Tube Co.

33 **Lamps**—Bulletin No. 121B is a 4-pp. folder on the characteristics and application of Birdseye Radiant Heat Lamps. Birdseye Lamp Sales Division, Wabash Appliance Corp.

34 **Cements**—How to make practical and lasting repairs to equipment and pipe lines without dismantling or use of heat, is described in a revised edition of the Smooth-On Handbook. 40 pp. with 170 diagrams and simple instructions make a helpful repair guide for engineers, mechanics, and maintenance men. Smooth-On Mfg. Co.

35 **Water Softeners**—Bulletin No. 605 describes a complete line of Double Check Zeolite Water Softeners. It contains a description of the Double Check principle, with close-up views of nozzles and other design features and lists a number of installations. Elgin Softener Corp.

36 **Steel Lockers**—Pocket Booklet 44-A contains 24 pp. of specifications with prices of the Penco line of heavy gage steel lockers, cabinets and shelving. Summarizes applications and points out possible savings in floor space. Penn Metal Corp. of Penna.

37 **Technical Data**—On an 8½ by 11 in. data card, No. 112, are given inch to mm. conversions from 1 to 30 mm., also comparison of metric-English weights. The Babcock & Wilcox Tube Co.

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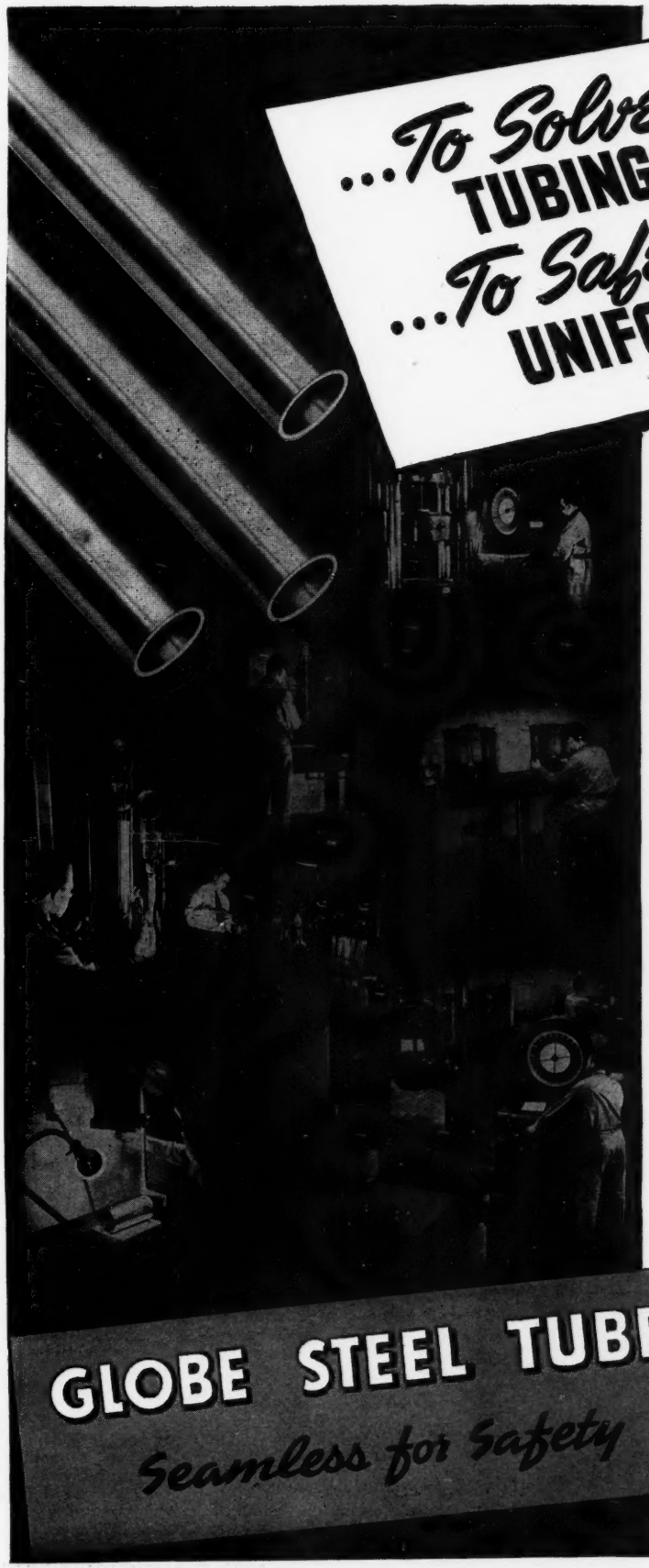

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Because they give efficient, durable service, more manufacturers are turning to W-S Forged Steel Fittings to speed production and lower maintenance costs.
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New Engineering Books

Foundations of Modern Physics. By Thomas B. Brown. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Size 6 by 9 in., cloth bound, 326 pp. Price $3.25.

Elementary Fluid Mechanics. By John K. Vennard. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Size 6 by 9 in., cloth bound, 345 pp. Price $3.50.

We do not condone multiple book reviews. In fact we heartily disapprove of them and ordinarily sidestep the question neatly by banning the reprehensible practice. This, however, is no ordinary occasion for we are dealing with two unusual books—two books different, yet reflecting a singleness of purpose in weaving a unified pattern from strands ordinarily considered as separate and distinct branches of engineering.

Theory? Yes, in that each deals with fundamentals, yet theory of the most practical kind which no practicing engineer can afford to ignore. Theory which ties each man's work in with that of the rest of the world in such a way that he can view his own efforts in relation to those of his neighbors and profit accordingly.

The average engineer works with basic theory formulated by and put in moth balls and neatly labeled "Finished" by the classical physicist generations ago. Electron physics, beginning about 1880, soon convinced these eminent gentlemen that the ultimate answer to Nature and all her whims was still far in the future. For all practical purposes this did not, however, cause the engineer any particular concern because different branches of physics, light, heat, mechanics, etc., were based on observation over a limited range.

Electron physics, developing along several different paths finally culminating in the theory of relativity, did, however, go far in demonstrating the fundamental sameness of all matter, its relation to energy and the correlation of all physical phenomena. Thus modern physics rests upon, and is an extention of, the earlier classical physics. Of recent years a great deal of thought and effort of modern physicists has been devoted to unifying the separate branches of classical physics.

Thomas Brown, professor of physics, George Washington University, has done an excellent job of presenting this late work in both an exact and elementary manner. A basic knowledge of classical physics is assumed, but the presentation itself may be termed popular, technical terms and phraseology are avoided except where fully explained, explanation is clear and concise, only elementary mathematics are used and all development omitted, the few equations necessary for clarity being presented as simple statements of fact.

In developing the book, historical order has been abandoned for a logical development from present day knowledge in order to simplify the approach for the beginner. From the elementary electrical charge and the electron, the book gradually develops through atomic and molecular structure, light electrical oscillations, the spectrum, crystals, energy, radiations, radio activity and cosmic rays to a brief and simple treatment of relativity.

Aside from the skillful way in which all branches of physics are woven into a single picture, the engineer will probably find the chapters on gas laws, molecular energy and heat transfer of most interest. In chapters 11 to 14 these phenomena are explained with remarkable simplicity beginning with the gas laws and working through the kinetic theory of gases, the effect of molecular structure on molecular heat, heat conduction in gases, energy and energy transformations, evaporation and Van der Waals' equation and radiation from hot bodies. While there are still gaps to be filled in, the fundamentally simple relationships dealt with by the engineer in thermodynamics are apparent—and enlightening.

What Professor Brown has done for the general field of physics, John K. Vennard, assistant professor of fluid mechanics of New York University, has done for a more restricted field a generalization and extension of engineering branches often lumped together under the general title of hydraulics. Certain phases, notably hydrodynamics, were understood and used by the early Greeks, hydraulics as a

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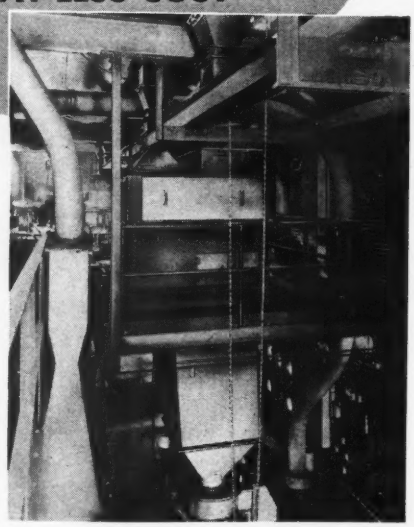

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48

practical science is, however, a development of the last 300 yr., while aeronautics is a practical development of the last generation.

Fluid Mechanics brings under one head all these problems, including the flow of, in, or, through any fluid. Thus it recognizes no arbitrary boundary between different branches of engineering. Dealing with a more specialized field, the theoretical development is more complete than Professor Brown's, but at the same time rigorous mathematical development has at times been sacrificed in the interest of simplicity and to convey physical conceptions for the benefit of beginners.

From fundamental physical properties of fluids, the subject is developed through statics, flow of ideal and real fluids, flow in pipes and open channels, fluid measurements, similarity and dimensional analysis, and flow about immersed objects. This last includes aeronautics, ship hulls, automobile and train streamlining, propellers, turbines and centrifugal pumps.

Psychrometric Notes and Tables. Revised Edition. By Elmer Torok. Published by the North American Rayon Corporation, 261 Fifth Avenue, New York, N. Y. 1941. 125 pp., 4½ by 7 in., flexible simulated leather.

This little handbook is designed not only to serve as a guide in solving psychrometic problems, but also to place all necessary information at the disposal of those interested in the subject. The author is the Superintendent of Power of the North American Rayon Corp. The volume is divided into six chapters, the first of which attempts to interpret all expressions and definitions related to psychrometry in a plain, intelligible manner in the form of a series of questions and answers. Chapter 2 contains a group of tables that will enable the occasional user to find all necessary information tabulated without the necessity of resorting to the more or less intricate steps that are unavoidable when one is attempting to find the desired data on the psychrometric chart. Chapter 3 is composed of material in the form of examples and solutions to illustrate the method of solution of practically every psychrometric problem. Chapter 4 is devoted exclusively to tables containing heat transmission coefficients for building materials. In Chapter 5 the method of determining the heating and cooling loads is described in detail. The concluding chapter is an alphabetical table of conversion factors most frequently used in connection with this kind of work.

Chambers' Technical Dictionary. Edited by C. F. Tweney and L. E. C. Hughes. First Edition. The Macmillan Co., 60 Fifth Ave., New York, N. Y., 6 by 8¼ in., 958 pp., cloth bound. Price $5.00

Persons engaged in technical work are not likely to appreciate the need for a book such as this until it is directed to their attention. Familiar, at least with the technical terminology of the respective branches of the field in which they are engaged, they rely on current literature and the published proceedings and transactions of scientific societies to keep them abreast of developments in scientific language. Yet, such people would find a good technical dictionary a distinct asset in conserving time and effort.

This dictionary seems to present a good, representative cross-section of the language of science and technology. Its aim is to give, in the light of current knowledge, definitions of terms that are of fundamental significance in pure and applied science as well as in all branches of engineering and construction.

On the whole, it is very well done. One inclined to be critical can find omissions, but they are relatively few, and in a volume of handy dimensions it would be surprising if there were not some omissions. All the definitions are the work of recognized authorities, many of them, according to the editors, formulated in this volume for the first time. The dictionary was compiled by a staff of thirty specialists under the editorship of Mr. Tweney and Mr. Hughes. Mr. Tweney is the editor of "A Technological and Scientific Dictionary" and Mr. Hughes is Lecturer in Electrical Communication at the Imperial College of Science and Technology, London. The following are some of the principal fields covered by the dictionary:

Acoustics and Sound Recording, Aeronautics, Astronomy, Botany, Building and Construction; Electrical Communications, Engineering, Geology and Mineralogy, Horology; Illumination, Medicine, Surgery and Veterinary Science, Metallurgy, Meteorology, Mining; Photography and Cinematography, Physics and Chemistry, Printing and Typography, Textiles, and Allied Trades.

The last 34 pages of the book are devoted to tables of the chemical elements, geological classifications of the vegetable and animal kingdom and a representative bibliography.

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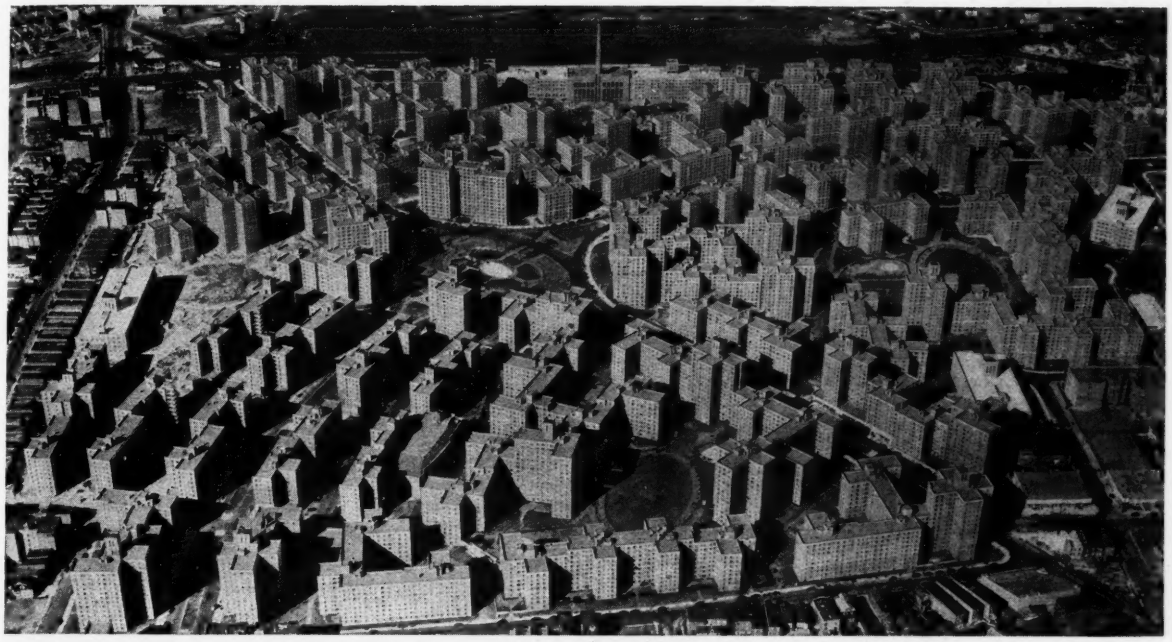

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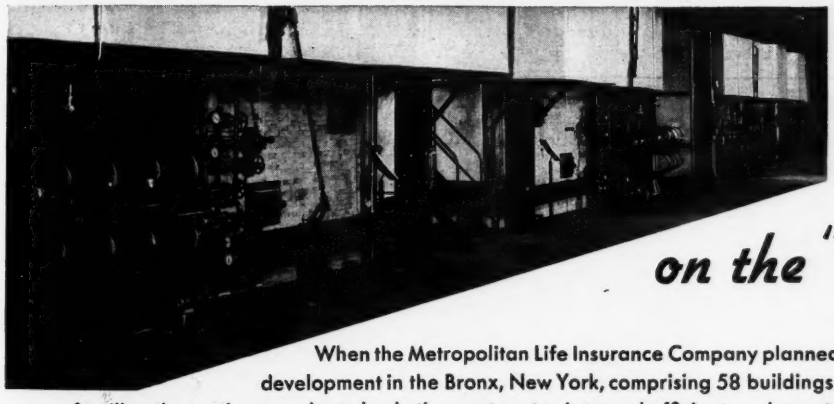

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PORTLAND (ORE.) ST. LOUIS SAN FRANCISCO SEATTLE TULSA

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Power Plant Construction News

Ark., Pine Bluff—Arkansas Power & Light Co., Pine Bluff, is completing plans and proposes to begin work soon on new steam-electric generating station in gas field area of the State, with an initial capacity of about 30,000-kw. The station will be of an outdoor type, with station equipment exposed. Orders for main equipment are being placed. Cost is reported to be about $2,500,000.

Calif., Bell—Thompson Products, Inc., 2196 Clarkwood Rd., Cleveland, Ohio, manufacturer of automotive products, valves, etc., plans installation of electric power equipment in a new branch plant at Bell, to be used for production of airplane engines and parts for the Government. The cost is about $249,500. A fund in that amount is being secured from Government for project.

Ind., Indianapolis—Eli Lilly & Co., Inc., Alabama and McCarty Sts., manufacturer of drugs and pharmaceutical products, plans installation of electric power equipment in a new four-story addition, 40 by 125 ft. Entire project will cost over $100,000. Robert F. Daggett, Underwriters' Building, is the architect.

Iowa, Boone—Iowa Electric Light & Power Co., Cedar Rapids, Iowa, plans extensions in steam department at the electric generating station at Boone, including installation of a new high-pressure boiler unit and auxiliary equipment. Cost is estimated over $500,000. This is part of 1941 expansion and improvement program of the company.

Ky., West Henderson—Atmospheric Nitrogen Corp., 40 Rector St., New York, N. Y., a unit of the Allied Chemical & Dye Corp., 61 Broadway, New York, has plans maturing for a new power plant at a Federal munition plant, known as Ohio River Ordnance Works, West Henderson, of the Federal Government, now in the course of construction. The station will cost close to $1,000,000 with turbine-generators, boilers and auxiliary equipment. Contract has been arranged with the Government for project.

La., Alexandria—The City Council is considering preliminary plans for extensions and improvements in a municipal power plant, including installation of additional equipment for increased capacity. Cost is close to $175,000, with equipment. Proposed to arrange a bond issue for the project.

Md., Baltimore—General Refractories Co., Chesapeake Ave., Brooklyn district, plans a new boiler house at a local plant. Erection is scheduled to begin soon and will be carried out by the company forces. Cost is reported about $35,000, with equipment.

Mich., Milan—Ideal Furnace Co., Milan, manufacturer of stoves, furnaces, etc., plans installation of electric power equipment in a new one-story plant, to replace a structure destroyed by fire several months ago. Cost is about $120,000. Giffels & Vallet, Inc., and L. Rossetti, Marquette Building, Detroit, Mich., are the architects and engineers.

Mich., Saginaw—Consumers Power Co., Jackson, Mich., has approved plans for an immediate erection of addition to John C. Weadock steam-electric generating station at the mouth of the Saginaw River. Work will include installation of a new 50,000-kw. turbine-generator unit, high-pressure boiler and auxiliary equipment, advancing the output to 120,000-kw. Completion is scheduled during the summer of 1942. Cost is reported over $5,000,000.

Minn., St. Paul—International Harvester Co., 180 North Michigan Ave., Chicago, Ill., plans installation of electric power equipment in a plant to be established at St. Paul, using certain existing buildings, for production of artillery, for United States Army. Entire project will cost close to $4,000,000, the majority of fund to be expended for machinery and equipment. Work is scheduled to begin soon.

Minn., Willmar—The City Council plans expansion and improvements in

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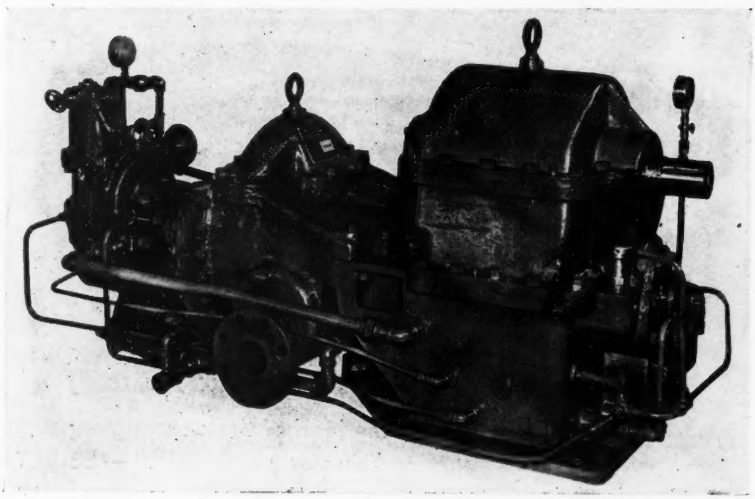

This photograph shows a 112 H.P. Murray high back pressure turbine and integral reduction gear for driving an induced draft fan.

Speed — 5000/1150 RPM
Steam — 415# — 620°F.
Exhaust—160#

Governor—variable speed for operation with automatic combustion control. 3 duplicate units serve a large boiler installation in an eastern industrial plant.

MURRAY IRON WORKS COMPANY, BURLINGTON, IOWA

a municipal power plant, including installation of additional equipment. Estimates of cost will be made at once. Williams & Burlingame, 214 West Williard St., Stillwater, Minn., are the consulting engineers.

Miss., Hattiesburg—South Mississippi Electric Power Association, Ellisville, Miss., O. L. Watson, president, recently organized, plans a new steam-electric generating station in the vicinity of Hattiesburg, which is estimated to cost close to $1,200,000. It will be used for a power supply for a group of electric co-operative organizations. Financing will be arranged through Federal aid. Gibbs & Hill, Pennsylvania Station, New York, N. Y., are the consulting engineers.

N. J., Jersey City—Public Service Electric & Gas Co., Terminal Building, Newark, N. J., has approved plans for an addition to the Marion power station, Jersey City, for expansion in its turbine department, and will proceed with erection this spring. Additional equipment will be installed for increased capacity.

N. Y., Penn Yan—New York State Electric & Gas Corp., Ithaca, N. Y., plans expansion in steam-electric generating station at Penn Yan, including installation of equipment for increased capacity. Cost is reported over $600,000.

N. D., Lisbon—The City Council has engaged Ray R. Gauger & Co., 2635 University Ave., St. Paul, Minn., consulting engineers, to make surveys and estimates of cost for a proposed municipal power plant. Preliminary figures total over $200,000. (Service is now being furnished here by Otter Tail Power Co., Fergus Falls, Minn., with the franchise expiring next fall.)

Ohio, Camden—The City Council has authorized completion of plans for a new municipal power plant, using Diesel engine-generating units and accessories. Cost is about $110,000, including street-lighting system. Bond issue has been authorized in the amount noted. Carl J. Simon & Associates, Inc., Van Wert, Ohio, is the consulting engineer.

Ohio, Cleveland—Cleveland Graphite Bronze Co., 880 East 72nd St., manufacturer of bushings, etc., plans a power plant with capacity of about 12,000 hp., at the new works at 16800 St. Clair Ave. Also will install electric power equipment in manufacturing plant, consisting of two main one-story units, 340 by 680 ft., and 100 by 200 ft. The entire project is reported to cost over $1,000,000. John H. Graham, Hanna Building, is the architect.

Ohio, Dayton—Dayton Power & Light Co., Dayton, has approved plans for an addition to a steam-electric generating station, and will begin work on superstructure soon. Additional equipment will be installed for increased capacity.

Ohio, Deer Park—The Village Council plans an early special election to approve a bond issue of $250,000 for a proposed municipal power plant and electric distributing system. Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer, will prepare plans for the station.

Ore., Portland—Oregon Shipbuilding Corp., Port of Portland, vicinity of Terminal 4, plans installation of electric power equipment in connection with new shipways and other plant expansion. The entire project will cost over $7,600,000. A fund in that amount will be provided by the Government for the project, with facilities to be used for construction of Federal vessels.

Pa., Johnstown—Bethlehem Steel Corp., South Bethlehem, Pa., plans expansion in steam-electric power plant at the Cambria Works, Johnstown, including installation of a new 20,000-kw. turbine-generator unit and accessories, boiler and auxiliary equipment.

Texas, Beaumont—Pennsylvania Shipyards, Inc., Beaumont, plans installation of electric power equipment in a new local shipbuilding plant for construction of vessels for the U. S. Maritime Commission, consisting of three shipways, shops and miscellaneous structures. A boiler house is proposed. The entire project will cost about $1,200,000. Appropriation in that amount is being secured through the Government.

Texas, Houston—Houston Lighting & Power Co., 1016 Walker St., is considering extensions and improvements in the local steam-electric generating station, including installation of equipment for increased output. Cost is reported over $750,000, with equipment.

Wash., Seattle—Associated Shipyards, Inc., Harbor Island, affiliated with Puget Sound Bridge & Dredging Co., same place, plans a new boiler plant in connection with expansion and improvements in the shipbuilding plant for construction of vessels for the Government. Entire project is reported to cost over $100,000.

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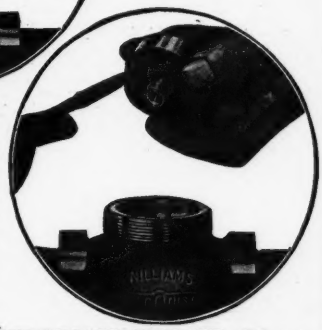
In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.



Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact its absorption is less than 1 per cent. . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.

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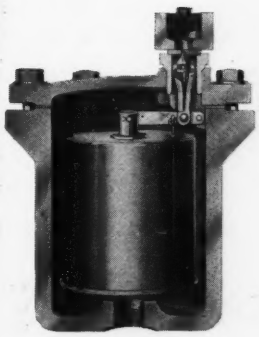

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